METALS and ALLOYS

The Engineering Magazine of the Metal Industries

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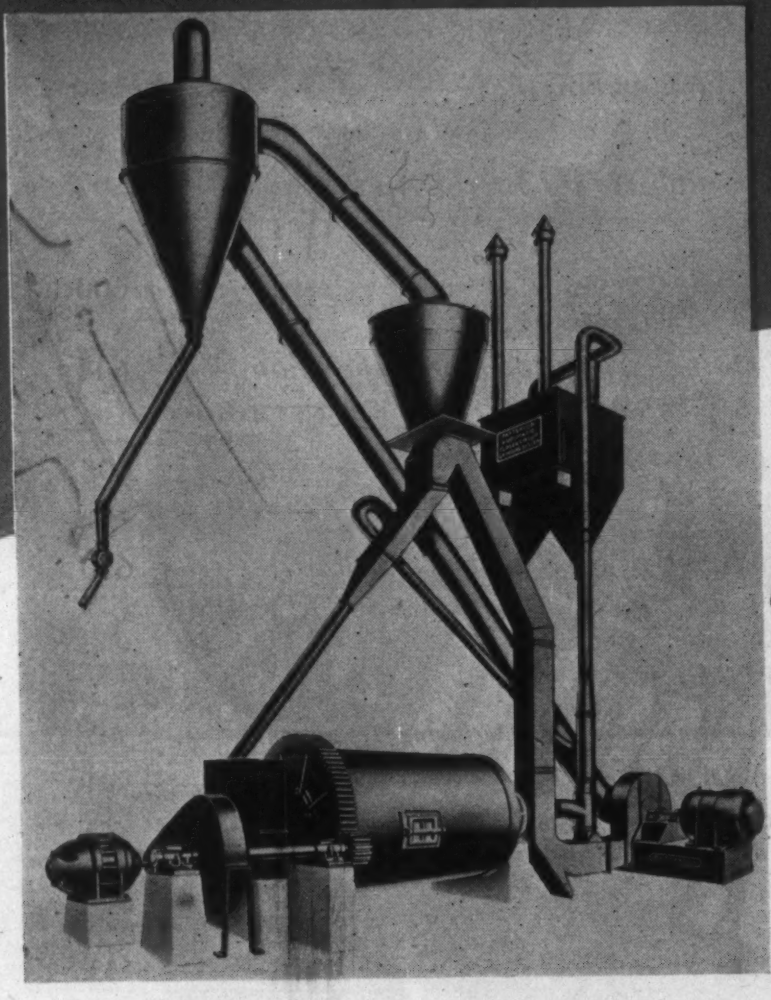
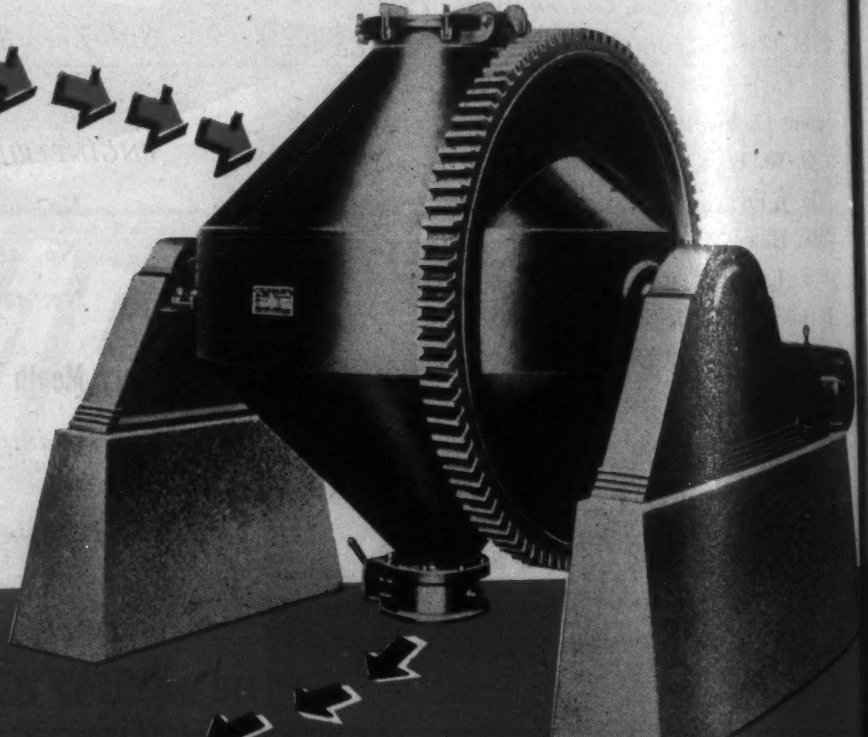
From your raw material

through

PATTERSON MACHINERY



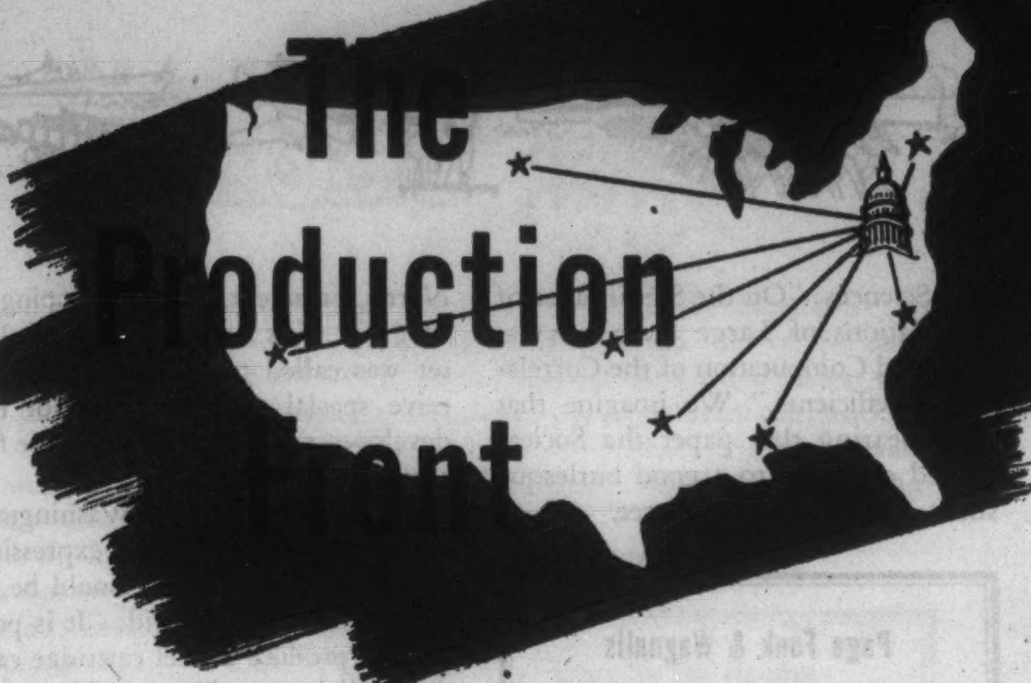


to **PERFECTLY DISINTEGRATED AND BLENDED**

Metal Powders

THE PATTERSON FOUNDRY & MACHINE CO.
EAST LIVERPOOL, OHIO, U.S.A.

The Production Front



by Harold A. Knight
News Editor

Tin continues the tightest of the metals.... Metals are less critical than textiles, fibre, plastics and lumber, for instance.... Aluminum critical point is sheets.... Policy as to copper leans towards "too much too soon."... Rhodesian copper competes with coal and chromium for railroad space.

Seven more steel projects recommended for abandonment, following five others previously.... Surpluses of valves and aircraft materials.... Labor is imbued with too much horseplay.... Cheapness of life on battlefront makes industrial workers careless.... "Imagineering" has taken on some kinfolk.

Steel cartridge cases said to be equal to or better than brass.... Army pronounces unlimited use for 3-in. case for anti-aircraft and anti-tank.... 1,354 pins on post-war map.... Hoffman, of C.E.D., gives out ideas.... Ten "pin-up boys" of industry.... Swimming pool on a post-war bus.... Plywood planes.

Are We Entering Era of Surpluses?

"Aluminum seems to be somewhat more than adequate for production and is available for further essential uses. This picture may change almost overnight with any radical change in requirements of the armed services." So stated the War Production Board.

"Copper is about balanced between supply and demand, and is made available for a few further essential uses, but its status may change suddenly," they continued. "Steel is about balanced between supply and demand for essential needs, but is subject to change, but changes would be less sudden than for copper or aluminum.

"Nickel, used chiefly in ferro-alloys, is short in supply and expected to remain so, though has shown considerable improvement. Tin is probably one of our tightest metals. We have stretched our supplies by downgrading, substitutions, electrolytic plating and salvage.

"Continued supply from Bolivia is now questionable, due to political developments. Zinc has varied in its status over the past two years, slab zinc just now being somewhat freer than last summer."

WPB issued its eleventh "Material Substitutions and Supply List" on Jan. 31, which showed an easing of copper and steel as to raw materials, though not as to facilities or manpower for fabricating them. This official list carries 450 materials needed in the war effort, in three groups, according to criticalness.

As groups, chemicals and plastics are somewhat tighter than on previous listings, with textiles and fibres about the same. Lumber, in which there is a continued serious shortage, shows neither improvement nor decline.

Aluminum Sheets, a Stress Point

In aluminum, sheets are the bottleneck. Philip D. Wilson, director, Aluminum and Magnesium Div., WPB, warns that sheet production must be stepped up immediately if 1944 requirements of the aircraft program are to be met.

He cited the 60% increase in airframe weight in 1944 over 1943. "Just because there has been a reduction in aluminum pig production, a misunderstanding has arisen concerning our need for sheet," he stated.

On copper, WPB's tendency is to have "too much too early." Michael Schwarz, director, Copper Div., WPB, stated: "One risk we cannot and will not take is to gamble with having insufficient copper on hand to meet the uncertain demands of war. Military requirements represent a challenge to management and labor.

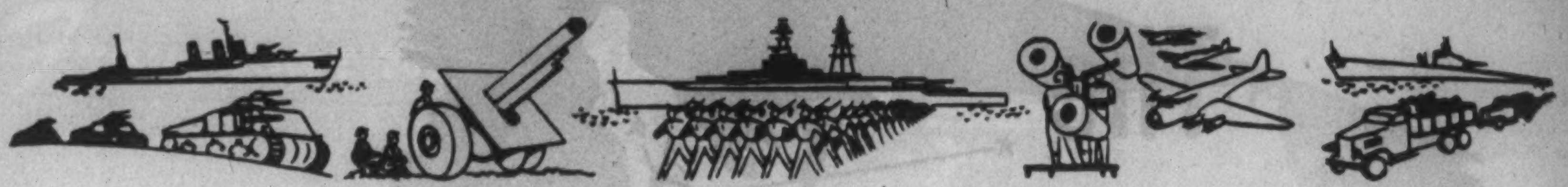
"We must not let down the boys on the battlefront. The cut in small arms ammunition production has already been offset by greater use of copper and brass in other military products."

The British Government is having a problem with Rhodesian copper. That metal is competing with vitally needed coal and chromium for limited rail facilities in that part of Africa.

On that subject British and United States members of the Combined Raw Materials Board recently issued the statement: "Though the copper position has improved in recent months, uncertainties of future production and military requirements are such that the United Nations should proceed cautiously with any program to reduce output or relax consumption."

Too Many Steel Plants

One gets confused, of course, by the many evidences of oversurpluses



one sees so often now. Thus, termination of work on seven more steel plant expansion projects in four states, costing $97,000,000, has been recommended by WPB, following five other projects previously recommended for the same.

All of these seven projects are from 50 to 98% completed. Of course, the companies that are mothering these projects may complete them with their own funds.

"Feast or a famine" applies to steel valves. A short half year ago valves were among our most critical components. Now WPB is offering 30,690 surplus valves for sale. Army Air Forces Materiel Command, 111 W. Jackson Blvd., Chicago 4, wishes us to publish surplus stock for sale, including raw and fabricated materials, standard parts, motors, hardware, precision tools, equipment, etc.

Is this, indeed, the beginning of an era when government agencies and private parties will fall all over one another in trying to dispose of surpluses? We recall the hodge-podge of materials seeking buyers after the first World War.

Horseplay Instead of Horsepower

As to the other chief element of production—labor—we have heard it emphasized of late that there is too much horseplay in plants. Not only does this slow production, but shows the wrong spirit in time of war. Limburger cheese is rubbed over telephones and typewriters in offices; in shops, lunch boxes are soldered shut; assembly parts are welded to steel floors to embarrass porters; workers are hazed by being blown up with compressed air hoses, sometimes resulting fatally.

Safety engineers complain that press and radio reports of death and injury on the battlefront have complicated the problem of promoting industrial safety because of generally-increased callousness among workers.

Realizing that we, too, may be accused of horseplay, but feeling that we have a message to put over, we should like to recommend the title of a paper read at the twelfth annual meeting of the Institute of Aeronautical Sciences: "On the Significance of Correlations of Large Scale Circulations and Computation of the Correlation Coefficients." We imagine that after hearing that paper the Society retired en masse to a good burlesque show, rows 1, 2 and 3, center.

Page Funk & Wagnalls

It was a great coup in thought engineering when some master of the written word in offices of the Aluminum Co. of America coined "Imagineering." We can see the idea spreading like the "Buy War Stamps" chain letter (eventually declared illegal). "Imagineering," of course, implies the thinking out of a new idea. Naturally, the idea being declared sound, "Productioneering" had to follow—and, sure enough, it has crept into print. Some enterprising advertising agency has already planted its flag on the word and captured it. Experimenting with electronics has by now become "Electroneering."

But we want to be first to apply it to the publishing field. So we do hereby state that the publishing of METALS AND ALLOYS *is Editioneering—and when we write those explanations under pictures, we are captioneering.*

And we hope when we bid this earth goodbye, despite all the questionable deeds we have done, we will go Heaveneering—and hope to meet all you readers there!

"Steel Cases Better than Brass"

"Your 3-in. steel cartridge cases are performing equal to, or better than, brass cases, and the Ammunition Branch, U.S. Army Ordnance Dept., has recommended to the ground forces that these cases be released for actual combat use."

So spoke Brig.-Gen. R. E. Hardy, chief, Ammunition Branch, to K. T. Norris, president, Norris Stamping & Mfg. Co., Los Angeles, when the latter was called to Washington to receive special commendation for the development of the 3-in. steel case for anti-aircraft and anti-tank guns.

After the ceremony at Washington, we contacted Mr. Norris, expressing surprise that steel cases should be so highly regarded. He said: "It is possible to produce a steel cartridge case that will be equal to any brass cartridge case now used. Should firing pressures of some of the sizes be increased, as is the tendency, they will exceed the limits of brass, and such cases will have to be made from steel.

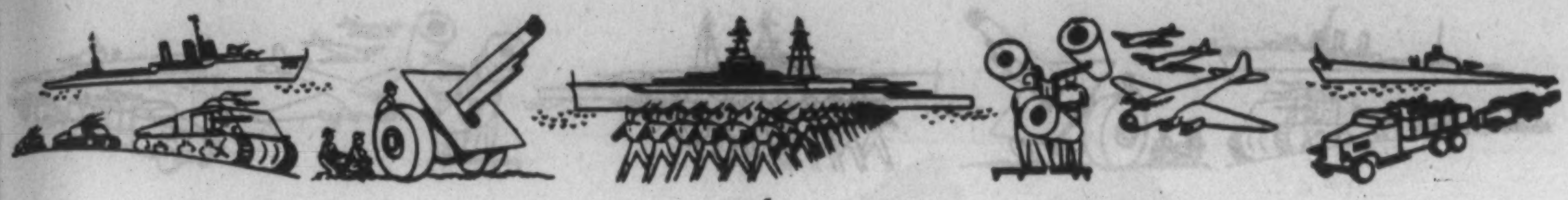
"It is regrettable that the first stories that were released by the Army Ordnance with reference to their switching some manufacturers from the manufacture of steel cartridge cases to the manufacture of brass cartridge cases implied that a successful steel cartridge case could not be made. More recent articles on this subject endeavor to correct this impression.

"When a cartridge case is fired, the case has to expand to the inside wall of the gun and then expand with the gun, but when the pressure is relieved, the cartridge case must contract sufficiently so that the outside diameter of the cartridge case is smaller than the bore of the gun.

"Because of its low modulus, brass has the natural ability to do this. For a steel case to perform in this manner it was necessary to increase its physicals to offset the higher modulus of steel. This can be done by cold working alone on those cases where the firing pressures are not too high, such as the 105-mm. howitzer case.

"On cases like the 3-in. A.A. cartridge, where the firing pressures are considerably higher, it is necessary to heat treat a portion of this case in addition to the cold working, to obtain the physicals necessary. In other words, if you start with a firing pressure the size of the case and the size of the gun bore, you can calculate the physicals necessary that a steel cartridge case will have to have to work satisfactorily.

"Steel cases started out as a substitute, but now the Army and Navy



look upon them as 'alternates' rather than 'substitutes.'

"It was unfortunate that the Army stopped production on steel cartridge cases with only so few sizes developed to a point that they would work to everyone's satisfaction. This could only give the impression to those not familiar that the program was a failure and that a satisfactory steel case could not be produced.

"Our company is in full production on the 3-in. A.A. steel cartridge case for both the Army and the Navy. The Army has passed our cases for unlimited use, which means that they can be shipped anywhere for use either as anti-aircraft or anti-tank ammunition. Our cases were put to every conceivable firing test before the unlimited use classification was attached to them.

"The Army has asked us to take on the job of completing the development work of the other sizes of steel cases. We have agreed to do this if space, machinery, manpower, etc. can be provided. We know that steel cartridge cases can be produced in all sizes, and we feel that this development work should be completed now."

All this is of particular interest in view of Chief of Ordnance Campbell's recent announcement that the use of steel for artillery cartridge cases has been abandoned and that Ordnance has reverted to brass to save man-hours, machine time and money. "Steel cases," he states, "cost more than brass cases, require a greater number of manufacturing operations and yield high scrap losses. Since the inherent corrosion resistance of steel is less than brass, steel cases are not as well suited as brass cases for use in humid tropical climates and are more likely to result in long-time storage complications."

Well, there's the pro and the con. Our observation has been that steel filled the breach when brass became short, but that almost everybody is glad to go back to brass. We'd like to hear some readers' opinions on this.

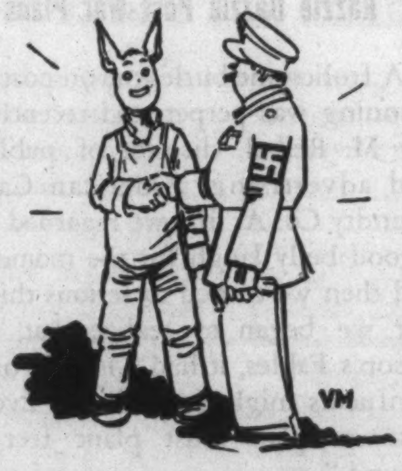
Thoughts on Post-War

We called on Paul G. Hoffman, president, Studebaker Corp., and chairman, Committee for Economic Development. On the wall of his office was a map of the United States, with the ubiquitous colored pin stuck in most everywhere,—1,354 to be exact,—representing where post-war planning under C.E.D. sponsorship or guidance is under way.

Cited by the Heinies
for service beyond the call of duty

by V. M. McConnell

News item: Plant managers and Government officials are alarmed at the wave of horseplay which has swept through many munitions plants.



There was once a wit
By the name of John,
Who soldered
The lunch box covers on,
And the other ridiculous
Things he did
On the company's time.
He was such a kid!
While over in Europe
A younger guy
Missed all the fun.
He was doomed to die
For the lack of one shell
Which was never made
Because of this John
And the pranks he played.

A personable man, indeed, is Mr. Hoffman—the opposite of a John L. Lewis. Calm tolerance, pleasing face and personality are first impressions. We asked questions and received answers.

Question: York, Pa., Canton, O. and Rochester, N. Y. were among the first cities to go about converting to war from peace in a big and well organized way. What communities seem to be farthest ahead in peace planning?

Answer: Memphis, Philadelphia, Minneapolis, St. Paul, Kansas City, and Janesville, Wis. are among the leaders. There is an especially fine spirit down South.

Question: What, in a couple of nut shells, is C.E.D. trying to do?

Answer: We are a non-governmental, independent organization of businessmen who have the common goal of making their maximum contribution toward a post-war national production level 30 to 45% higher than in 1940, our banner peacetime year, a level that is expected to provide 7 to 10 million more jobs than in that year. This represents what most people mean when they speak of full employment.

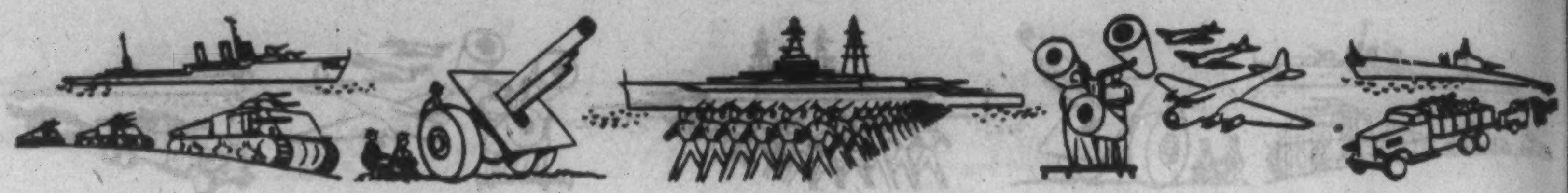
Question: Has any city or community yet thoroughly analyzed its post-war possibilities?

Answer: Janesville, Wis., a predominantly industrial city, 23,000 population, foresees 8% more jobs when war orders cease than during its present period of peak production—this is based on a thorough company-by-company estimate. It has in mind 8,029 specific jobs or 332 more jobs than it will have workmen to fill until others come in from other communities.

Question: Are there any "problem childs" among the various cities and communities?

Answer: Toledo, population 300,000, has had very severe ups and downs, particularly in the 1930 depression. It is largely dependent on Detroit and the automobile industry. Few of its manufacturers sell their output directly to consumers. But the war has broadened their experience and vision.

A survey revealed that of 350 local industries, 200 of which have more than 100 workers each, only 32 have research facilities for working out new products and new markets. The plan now worked out is to pool the technicians and laboratory facilities. To-



ledo hopes to be less dependent on the automobile industry in post-war.

Philadelphia, unlike Toledo, has a great diversification of industries, 1800 in fact. But here again research and clearing house for ideas and information are being emphasized and planned for.

Question: To what extent should public works be depended on to give employment?

Answer: Not more than 5%.

Question: Are there any important points we have not touched on?

Answer: Throughout the American post-war program the emphasis must be on—not creating so many jobs—but on increasing the amount of goods and services; then the jobs will be there automatically. Moreover, they must be extremely useful services. Fifteen million men raking leaves means nothing.

Take the housing industry. This has not flourished because houses have not been a "good buy." Prices are too high for value received, say by comparison with an automobile or refrigerator. Again, we believe in high wage rates, but lower unit of labor cost. Prices of goods must be cheap. Aluminum suffered for many years because they did not bring the price down fast enough.

Ten Pin-Up Industrialists

Henry Kaiser was voted nation's top business and industrial leader; second place went to William S. Jack, president of Jack and Heintz, Inc., Cleveland; with 80-year-old Henry Ford in third place. The balloting was carried on by workers of the Irving Subway Grating Co., Long Island City plant. Kaiser nosed out Jack by six votes, with Ford only 11 votes under Jack. Hence these three "pin-up" boys ran close.

Others named among the "top 10" industrial leaders, according to their rank in the poll, are: Glenn L. Martin, president of Martin Aircraft, Baltimore, Md., fourth; Capt. Eddie Rickenbacker, president of Eastern Air-lines, fifth; Larry Bell, president of Bell Aircraft, Buffalo, sixth; Charles Kettering, chief researchist, General Motors, seventh.

Donald W. Douglas, president of Douglas Aircraft Co., Santa Monica, Calif., and R. E. Gillmore, president of Sperry Gyroscope Co., both tied for eighth.

And Charles E. Wilson, president of General Electric, Colby M. Chester, chairman, General Foods, General William B. Knudsen, of the War Production Board, Lamont DuPont, chairman E. I. duPont de Nemours & Co., Inc., and Eugene E. Wilson, president of United Aircraft, all tied for ninth; and Harvey J. Firestone, Jr., president of Firestone Rubber Co., Eugene R. Grace, chairman Bethlehem Steel Corp., and Philip E. Johnson, president of Boeing Aircraft, all tied for tenth.

Razzle Dazzle Post-War Plans

A frolicsome burlesque on post-war planning was perpetrated recently by Jay M. Reibel, director of publicity and advertising, American Car & Foundry Co. At first we regarded it as a good belly laugh for the moment—and then we turned to serious things. But we began to realize that, like Aesop's Fables, it had a moral—or, as Confucius might have said: "Even a post-war plan must plant feet on ground."

This burlesque to end all burlesques is a blueprint of the "600 Passenger Bus of Tomorrow (or some day next week)." Among the more novel features are a lake within the bus for motor boating and fishing; a landing deck for sight seeing helicopters; a trolley giving "around-the-deck" service; a swimming pool, with a net to catch high divers who overshoot the mark while bus is in motion.

There are certain engineering problems, such as how to waterproof the passenger compartment against the swimming pool; how to use the draft created by the helicopter rotors for ventilating; how to mosquito-proof; how to fertilize the roof garden. But apparently these have all been solved satisfactorily.

Like fighting the war itself where we must battle inch by inch, mile by mile, with no magic formulas for strategy and tactics, so will winning of a prosperous peaceful life involve homely truths and plans. The spectacular razzle dazzle techniques and commodities, like smashing atoms to obtain power, will not come "some day next week."

Plywood Planes

The British Mosquito bomber, which has been so successful in raids over Germany, is a plywood plane, as is one of Russia's best fighter types. Plywood, in a plane designed for construction with that material, can eliminate one of the headaches of the metal "stressed-skin" aircraft-flutter.

While the metal skin has high local strength, an elaborate system of bracing is necessary inside the airfoils to prevent this vibration of the metal sheet. Plywood, constructed as a "sandwich" material, with a layer of end-grain balsa in the middle, is light in weight and at the same time sufficiently thick to give rigidity without a multiplicity of braces and frames.

Construction of these sandwich materials is an excellent example of strength by designing. The balsa, affording very little strength in itself, acts similarly to the web in a beam, while the plywood layers on the outside carry the stresses. The section is given a large moment of inertia by this use of materials.

Similar sandwich materials, using plywood, metal, rubber, plastics, etc., have been developed in this country through the use of the new adhesive bonding processes, such as cycleweld-ing, reanite bonding, and others. A new group of materials of construction, with an extremely wide range of properties, is thus created for the designing engineer.

Some of these materials have already been incorporated into present-day construction of both war and non-war articles. We have seen metal-sheathed plywood panels in railway cars, paper clad with metallic copper for building trim, rubber-clad metal equipment for handling corrosive chemicals, and many others.

With the return to a peacetime economy this list is certain to expand greatly in all directions.

editorial

A Wartime Goal Attained

We hear much of the large tonnages of pig iron and steel ingots which have been and are being produced — a fact decidedly gratifying. More or less lost sight of, however, is the outstanding achievement of increased capacity accomplished at the same time.

When the Defense Program was set in motion in 1940 — better known as the Emergency Wartime Construction Program — additions of about 10,000,000 tons to both the pig iron and steel making capacity were suggested. Many then proclaimed that this was impossible — "a pipe dream" — if maximum production was to be maintained simultaneously.

Data recently released by the American Iron and Steel Institute, assembled in tabular form, show the capacities in net tons of pig iron and steel, now and four years ago.

These statistics reveal that in that period the pig iron capacity has been expanded by nearly 12,000,000 tons and the steel capacity by more than 12,000,000 tons. Both of these exceed the 10,000,000-ton goal set in 1940.

	Capacity, Jan. 1, 1940	Capacity, Jan. 1, 1944
Pig Iron	55,723,640	67,391,270
Steel Ingots	81,619,496	93,652,290
Electric Steel	1,882,630	5,350,880

Comparable to this and even more sensational is the expansion in electric steel capacity — nearly 300 per cent — in the 4-year period.

To expand capacity to these large volumes and at the same time to operate furnaces at an average of 95 to 100 per cent of capacity is a metallurgical and engineering achievement of the highest order — one that the industry and the nation can justifiably be proud of and one unequalled by any other country.

This should put a damper on those who rail at big industry. Had not the large American industries put forth their maximum efforts, the war might already have been lost.

—E. F. C.

Design—"Stark Simplicity" or "Useless Decor"

When the veterans of the first world war came home they refused to don some of the pre-war uncomfortable clothes, such as stiff separate collars and pointed toed shoes. They wore instead soft collars attached to shirts and broad pointed toes. They had been so comfortable in uniforms that they intended to stay comfortable in civil life.

And the same may be true again after this war—not only as to clothes but "ships, shoes and sealing-wax." We were intrigued by the article on "General Product Design Trends" by Peter Muller-Munk, product designer and Carnegie Tech professor, in the January issue of METALS AND ALLOYS.

Positive Identification of Ryerson Alloys

Confirms Quality . . . . . Prevents Shop Errors

Each bar of alloy steel in Ryerson stock is painted on the end to indicate the type of alloy . . . and then stamped on the side near the end with the number of the heat from which the bar was rolled. Smaller size bars are bundled and tagged with similar identification.

This is important to you, because it offers an unmistakable means of verifying the alloy steel you receive from Ryerson. Also, both heat number and color marking are recorded on the Ryerson Alloy Steel Report that is furnished with each alloy shipment. The Report Sheet contains accurate data on the analysis, working temperatures and the heat treatment response for quenched and drawn 1, 2, 3 and 4 inch rounds of the steel you receive. This gives you reliable information for heat treatment that will produce the desired result.

This unique and valuable Ryerson alloy service is one of many reasons why it will pay you to concentrate your steel purchases with us.

Joseph T. Ryerson & Son, Inc., Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON

> One of the healthiest influences of war upon design has been the rediscovery of shape, once the glittering peace time trim was removed. It can only be hoped that the stark simplicity and ruggedness of ordnance equipment will not again disappear in a new orgy of useless decor. Shape as a functioning element of products and not as an arbitrary housing over mechanisms has too well proven itself to be easily forgotten.
>
> The trend is towards integral materials and away from highly mirrored plate finishes of the past. . . . Finish is being considered an integral part of a product rather than a purely dazzling surface film.

Since publication we have asked Mr. Muller-Munk for illustrations. As to shape, he named the jeep, sturdy and compact, with parts accessible and a certain rugged beauty in its very homeliness. Take army luggage—"You can get at it without opening the whole d . . . thing. Clever, with its canvas body with leather bracing." Then take the machine gun package as put up for our Army—a marvel of ingenuity in its efficiency and ease of handling. The new package consists of a moisture, vaporproof plastic film, sealed around the machine gun, which in turn is suspended on a cradle within a wooden box. A precalculated quantity of moisture absorbing desiccant is sealed inside the film. When opened the machine gun is ready for action immediately. Previously, guns were coated with grease and it took eight hours to degrease them and get them ready for action. Take the army canteen of blown plastics—perfect in shape to fit the body, drink out of and stand all sorts of abuses in all climates. At the other end of the scale Mr. Muller-Munk pointed a finger of scorn at certain pre-war automobiles where the fender blends into the door—a useless bit of design rigamarole.

Illustrating where finish is an integral part of the product are such materials as stainless steel, aluminum, plastics, plywoods, etc. which carry their own finishes. No plating to wear off, no enamel to flake.

It can be, too, that women's experience in war plants has made them wise as to the relative merits of "simplicity" and "useless decor" in the daily things they buy.

—H.A.K.

The ASM's New Literature Review Service

We want to be among the first publicly and heartily to congratulate the American Society for Metals on the establishment of its new metallurgical literature review service, which began publication in the February 1944 issue of the ASM *Review*. This is a very real contribution to the scientific welfare of our metal industries, especially significant in this case because there is neither profit nor glamour attached to it.

Every scientific group in every country needs a comprehensive classified abstract service, covering the foreign and domestic literature in its field. American chemists have *Chemical Abstracts* and our ceramists have *Ceramic Abstracts*. British ferrous metallurgists use the abstracts published in the *Bulletin* of the Iron and Steel Institute and their nonferrous brethren in the Institute of Metals also have an excellent abstracts service slanted in their direction. But where have we stood in America up to now?

From 1929 to 1940 METALS AND ALLOYS published a complete abstracts service (very similar, indeed, to ASM's present plan) for American metallurgists but it was forced reluctantly to abandon it in favor of a quite different department (our present Digests), in the face of overwhelming evidence that such a complete abstracts service, however valuable to the technical development of its field, is read and used only by a relatively small group — chiefly technical experts, research staffs, librarians, etc. who have the time, the access to foreign and obscure publications and the linguistic ability required for its proper use. In our field we had to admit that the metallurgists used our abstracts service but that the engineers and plant men merely leafed through it. Since we had become a magazine for engineers and production men even more than for metallurgists we could no longer justify the tremendous expense of a truly complete abstracts service, so switched in 1940 to a plan designed especially for the more practical engineering type of reader.

This plan — the present Digest department of M&A — pre-selects for the busy reader the outstanding engineering articles in our field and then presents enough of the original material so that the practical man for whom they are designed can keep generally up-to-date without having to refer to the originals. It will be seen at once that the ASM's new service will not be in competition with METALS AND ALLOYS' digests, which serve a quite different purpose and appeal to an entirely different type of reader.

Since we discontinued our publication of the complete abstracts service, we have continually hoped that one of the technical societies would fill the gap we left. Though they were few in number, the important people who needed the abstracts needed them badly. Because of its fundamentally scientific appeal and need for subsidization, an abstracts service is a natural function of a responsible and prosperous scientific body. Our examination of the first issue of the ASM's new service indicates that it is being handled expertly and thoroughly, and with an eye to the user's convenience. So American metallurgists will have their abstracts again, and an orchid to ASM for seeing and filling this need!

—F.P.P.

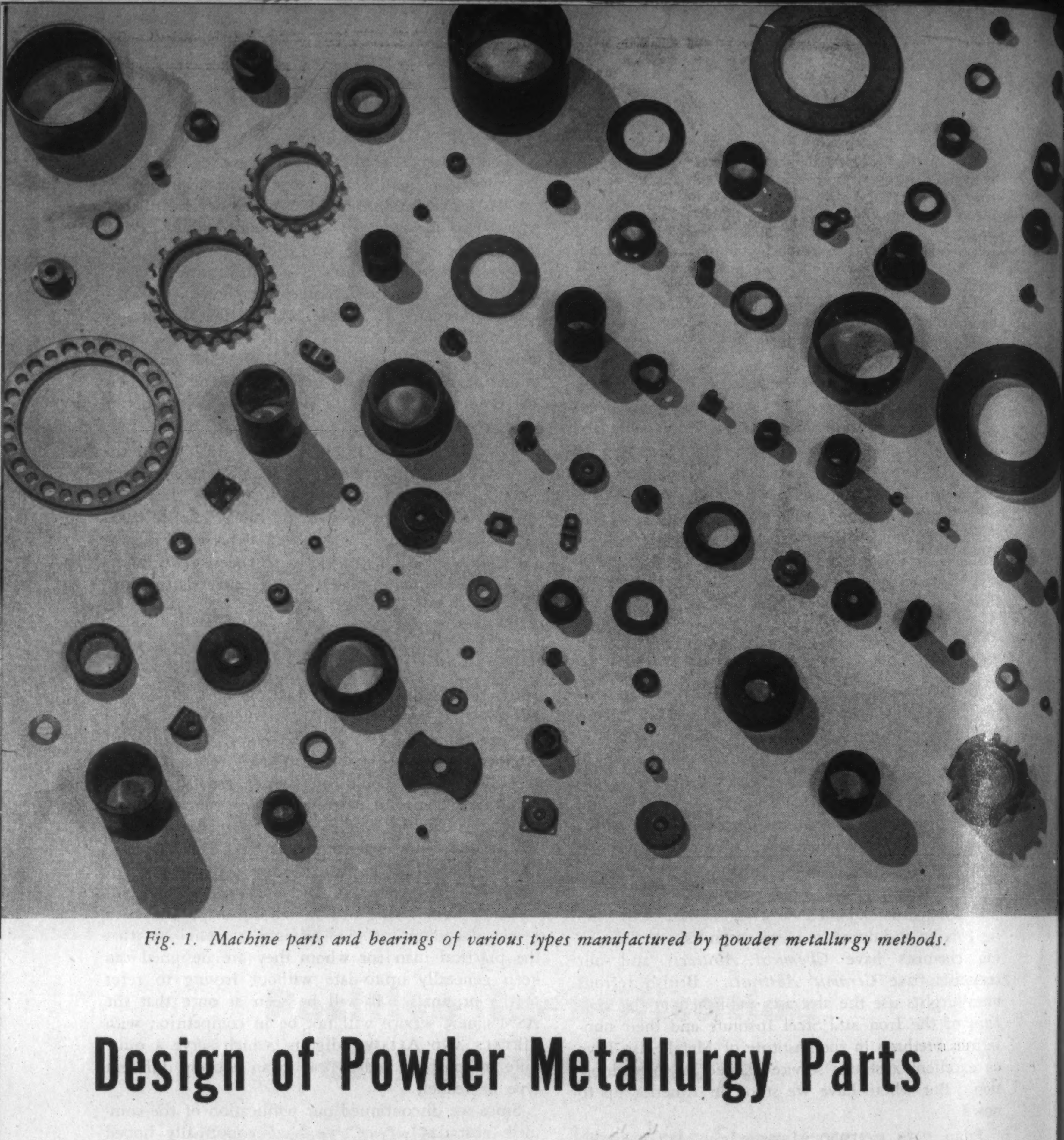


Fig. 1. Machine parts and bearings of various types manufactured by powder metallurgy methods.

Design of Powder Metallurgy Parts

This article is a happy effort on the part of your editors to "kill two birds with one stone"—to publish an article on powder metallurgy that will present down-to-earth practical information of a helpful rather than a merely promotional nature, and to publish an article on "designing for powder metallurgy" to join the editorial series on metal-forms for the engineer, which has already included articles on permanent mold and die castings, sand castings, cold headed products, etc. The authors discuss the competitive advantages and disadvantages of powder metallurgy as a fabricating process, and present several basic design rules specially applicable to powder metallurgy parts. —*The Editors.*

By M. T. VICTOR and C. A. SORG

Service engineer and production engineer, respectively, Keystone Carbon Co., St. Marys, Pa.

POWDER METALLURGY has come a long way in the last ten years, especially with respect to the number and nature of new applications developed for the process. Originally used almost exclusively for materials or products that are impossible or difficult to make by conventional melting, casting and shaping methods, the process has in recent years been extended to compete with established forming methods on economic, production-speed or material-conservation grounds.

For many products, pressing-and-sintering exactly or nearly to final dimensions has been found to be cheaper, to involve less machining and therefore less waste metal or to permit higher production rates than machining the parts out of bar stock or die casting, drop forging or cold-heading them. Today, many parts are being made quickly by compression molding that formerly could be produced only by tedious hours of machining, milling, slotting, grinding and drilling. These powder-metallurgy-made parts are being produced at a higher rate of speed and maintained to closer tolerances than machine-made parts, and at a great saving in cost. These parts not only are effecting a saving, but also are responsible for doubled production in many plants owing to their dimensional uniformity, thereby eliminating hand fitting of each part.

At the same time many other parts have been found not suitable for powder metallurgy fabrication in competition with other forming methods. There are so many factors that determine the economic and technical feasibility of competitive production of a part by powder metallurgy *and these are so closely related to the mechanical requirements, geometry, quantity considerations, etc. of each particular part* that each part must be considered as a separate problem to which easy generalizations may not necessarily apply.

In other words a part is not *a priori* a "natural" for powder metallurgy just because it is now being made by some other method involving considerable machining. Powder metallurgy fabrication is useful *within definable limits,* and it involves a group of design principles that are peculiar to it and which must be applied, sometimes laboriously, to each product under consideration before the latter can be classed as suitable or unsuitable for this method of manufacture. Broader understanding of these design principles would reveal some parts to be unsuitable for powder fabrication at the outset and thus avoid wasted time, effort or money or prevent misapplication. At the same time widespread knowledge and use of the fundamentals of powder metallurgy part design would assure correct design of and therefore better economy or service performance from many parts made in this way, thus tending to expand the use of powder metallurgy in the right direction.

The purpose of this article is to set forth those design principles that the engineer should apply to utilize fully the actual advantages of powder metallurgy parts. Because the major applications of such parts include those in which the powder method is used because it provides a special structure or quality not obtainable otherwise, as well as those in which powder metallurgy must compete with other methods, we will here discuss design factors that could apply to both groups, with particular emphasis, however, on the competitive-with-other-methods aspect.

What Powder Metallurgy Can Do

Before he can even consider having a particular part fabricated by powder metallurgy the engineer must know how that process compares in general with other manufacturing processes that might be used. He is particularly interested in costs, precision and tolerances, rates of production, mechanical or structural qualities and design limitations. It is not enough to know that in separate instances, powder metallurgy has been successful because it has provided one or more of the following: Structures or alloys not possible by other methods, built-in lubrication for moving parts, controlled density variations, more economical fabrication, shorter tooling time, higher production rates, surfaces of greater wear resistance, maintenance of closer tolerances, elimination of a secondary operation and set-up, or the use of a less critical material. More specifically the designer wants to know *under what circumstances* and in many cases *to what extent* these improvements become available. (We can assume here that he understands the nature of the process—*i.e.,* that it involves the pressing of metal powder mixtures in a die or mold to give a "green" briquette, which is then "sintered" and brought to service strength by heating to some temperature below its melting point and is often re-sized by a final coining operation.)

Powder metallurgy is able to provide certain structures or "alloys" that are not possible by methods involving melting. A structure like that of tungsten carbide tools and dies—hard refractory "metal" particles bonded with a tough matrix—can be produced only by powder metallurgy. Duplex structures like those of electrical contact materials, with a hard high-melting constituent uniformly dispersed in a tough, low-melting high conductivity metal, are musts for powder fabrication, especially where the service requires maintaining the separate technical identities of the constituents. Highly porous structures in which the porosity is uniform and controllable, as in self-lubricating bearings and porous metal filters, and metal/non-metal combinations like graphite-bronze bearings, carbon brushes, metal-plastics mixtures, friction materials, etc. are familiar specialties of the powder metallurgy process.

Powder metallurgy is often a more economical fabricating method than others that could be used for a particular part. Powder metallurgy involves fewer total operations than do competitive processes, costly machining is largely eliminated and material waste is held to an absolute minimum because parts can be pressed, sintered and cold-forged to finished dimensions. For each part or product the engineer should set down these advantages against a background of the number of parts to be produced, the desired production rate, the mechanical requirements of the part and the dimensional accuracy required before deciding for or against powder metallurgy.

Powder Metallurgy vs. Other Methods

Metal powders usually cost more than the raw materials used for making similar products by other methods. Tools and dies are expensive and for each job there is a minimum number of parts that must be produced from a set of dies in order to meet these charges economically. Final sizing or machining operations necessitated by ultra-narrow tolerances or by cross holes, undercuts, etc. in the design cost money, too. In some cases these items are so formidable as to offset the positive cost advantages the process offers, and other methods can be shown to be more economical.

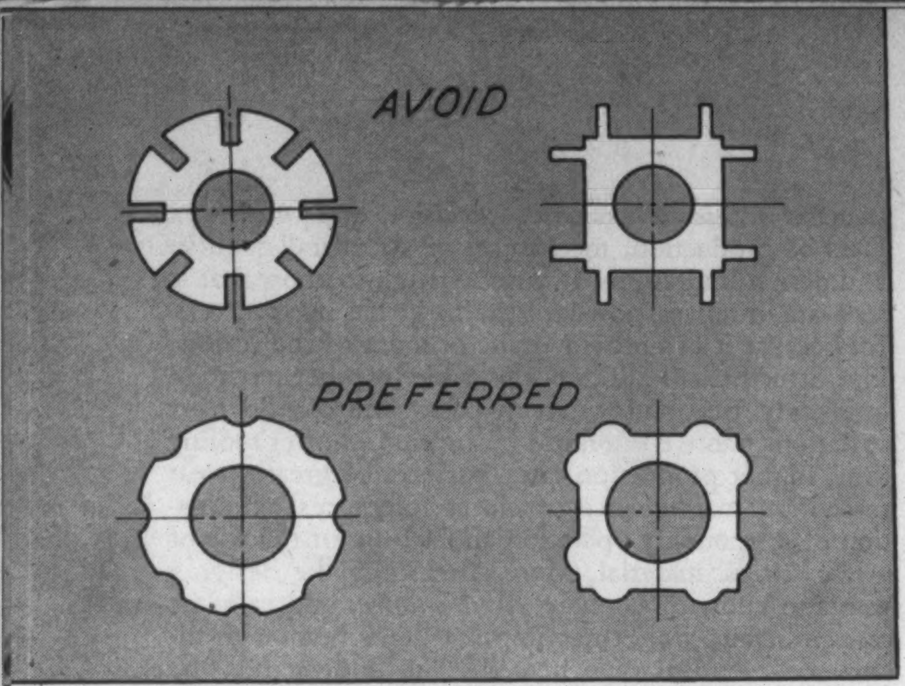


Fig. 2. Designs requiring very narrow and deep splines should be avoided in powder metallurgy work. The splines at the top of this drawing are difficult to mold, while those at the bottom are more readily molded.

As compared with other processes, powder metallurgy involves relatively high raw-material cost (sand casting is about the lowest), whereas the material-waste from powder metallurgy is virtually the lowest of the competitive fabricating operations (here machining and sand casting are poorest). Tool costs for powder operations are among the highest, with sand casting or cold heading attractive in this respect. Labor charges, however, are highest for sand casting, sometimes high for forging or stamping and low for automatic operations like die casting and powder metallurgy.

Production rates are highest with die casting and screw machine fabrication; they are high—occasionally very impressive indeed—with powder metallurgy. Optimum lot sizes may be small with sand castings, and permanent-mold castings; they are usually large with die casting, drop forging and (with some notable exceptions) very large with powder metallurgy.

Tolerances are widest with sand casting—$\pm\frac{1}{32}$ to $\frac{1}{16}$ in. being normal with small castings—and can be the closest with screw machine operations, where ±0.0002 in. is not unusual. Powder metallurgy is the next closest, with tolerances of ±0.0005 in. attainable, and even closer possible on special production jobs. Die casting and stamping come next, depending on part dimensions, both being accurate to ±0.001 in. The largest and the thickest parts are most economically made by sand casting or hot forging, and the thinnest parts usually by stamping, although very thin or tiny parts are being made by die casting, screw machine work and powder metallurgy.

The foregoing is not intended as a designer's guide (since there are many valid exceptions to most of the statements made) but as a reminder that there are often several ways of making a product and several factors to be considered in choosing among them. Design flexibility is often the controlling factor in process selection and powder metallurgy must be classed along with die casting and drop forging as having definite design limitations whose understanding is essential to intelligent application.

Design Factors and Limitations

There are several limiting factors that apply to all classes of powder metallurgy parts. Some have been mentioned comparatively above and several are interrelated in complex ways. From our own experience the most important for the engineer to remember are given below.

Powder metallurgy is primarily a process for large volumes. Most operations proceed at the rate of 200 to 1600 parts per hour, depending on the shape and size of the part. A new die or mold is of course required for each part of different design or size. These dies must be installed in presses and adjusted for operation, and this operation (known as "setting-up") requires from 1 to 30 hr. depending on the shape of the part. The more complicated the part, the longer is the time required. It sometimes requires more time to set up than to manufacture the number of parts required.

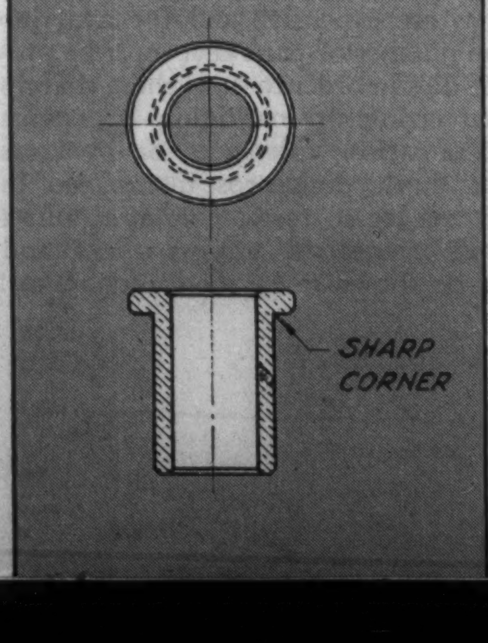
From the foregoing it can be seen that the unit cost decreases as volume increases. It is necessary to have minimum runs of from 500 to 50,000 depending upon the size and shape of the piece. The smaller the piece, the more volume is required to justify die costs and setting-up charges.

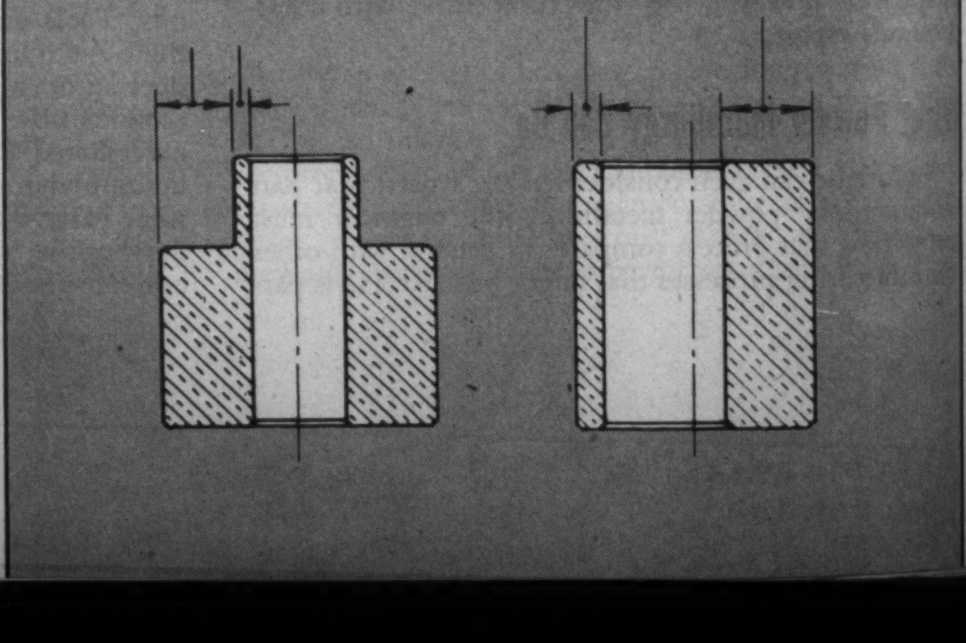
Tolerances should always be as liberal as possible, although molded parts can be held to very close limits; but when they are more restrictive than ordinary commercial tolerances, the molder must resort to costly individual gaging. Radial tolerances of ±0.001 in. and axial (in the direction of pressing) of ±0.005 in. are readily met.

Also to be considered is the wearing of the dies which must be designed and fabricated to very close tolerances. The finest grade of hardened die steels are

Fig. 3 (left). Avoid sharp corners where possible. These are difficult to mold and require extra operations. A minimum of 0.010 in. fillet radius should be provided.

Fig. 4. Large and abrupt changes in thickness, as in the part at the left, and uneven cross sections like those at the right are difficult to mold and should be avoided.





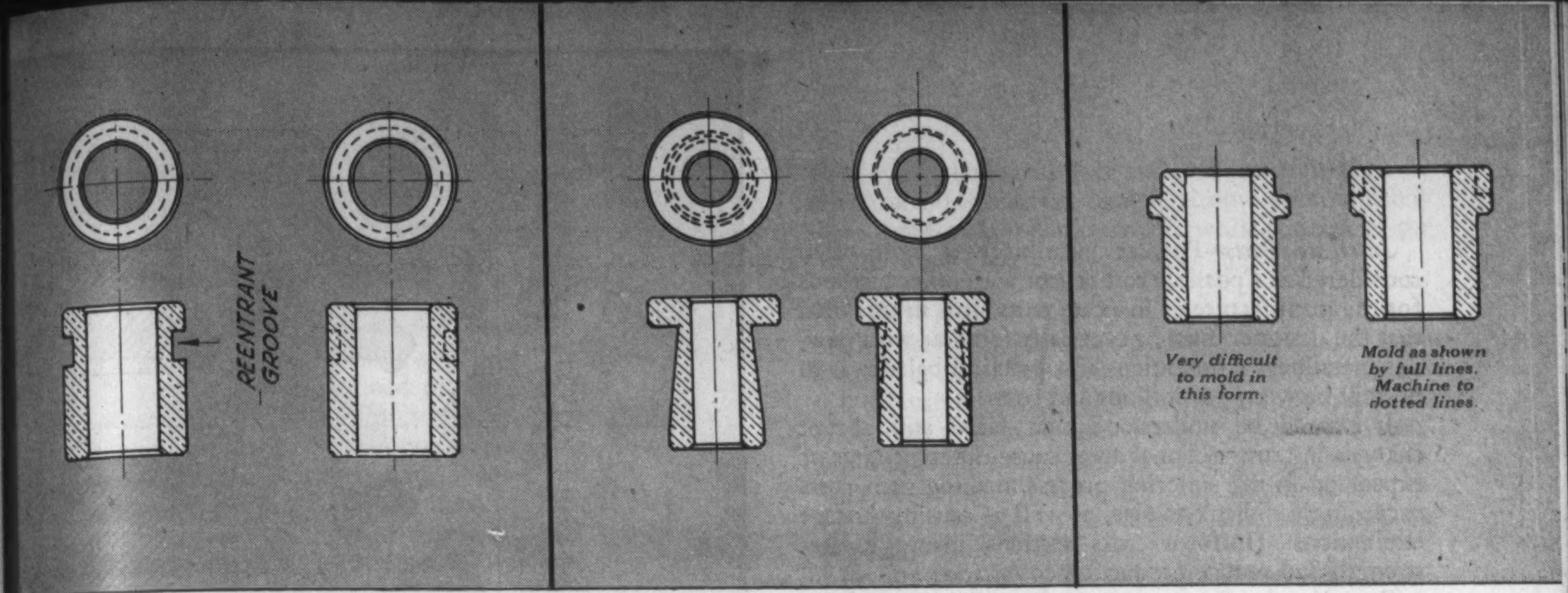

REENTRANT GROOVE
Very difficult to mold in this form.
Mold as shown by full lines. Machine to dotted lines.

Fig. 5. Parts having re-entrant angles or curves and undercuts cannot be molded. In each of the cases illustrated here the part cannot be molded in the form shown at the left but should be molded as at the right, with straight sides (shown by the solid lines) and then machined to the dotted lines.

used and the various parts are ground and polished to a high degree of accuracy. There is a certain amount of die wear caused by friction in ejecting the part from the die. A die averages about 50,000 pieces before excess wear causes such a "loose" fit that the die must either be repaired or replaced.

Shapes that require a die of weak design should be avoided, for molding dies are subject to enormous pressures (up to 100,000 p.s.i.) and parts of weak design will collapse. Avoid parts necessitating feather edges, very small pins, very narrow and deep splines on die parts. (See Fig. 2)

Avoid holes at right angles to the central hole or to the axis of pressing. Such holes cannot be molded but necessitate an extra machining operation. Internal and external threads cannot be molded either, but must be machined by an extra operation.

The length of the part in the direction of pressing should be comparable to the cross sectional area since all pressing is brought from top and bottom only. An extremely long piece will have unequal density; *i.e.* a soft spot in its center.

It is important that all molded parts be made with edges beveled and that internal angles have fillets. The reason for this is that as the die parts wear, the powder will work into the resulting crevice and form a fin or flash on the molded part and internal angle.

Metal powders have almost no lateral flow in the mold as has a liquid or a plastic, but must be placed in the die in its relative final molded location; consequently, almost every level on the finished product requires its own separate die insert which moves or floats in relation with other die parts.

Powdered-metal parts are usually made in three grades. Each grade is of a higher specific gravity and inherent physical strength than the preceding grade. A considerable increase in price as well as a reduction in rate of production is caused by raising the physical strength requirements from the lowest grade to each succeeding higher grade.

Inserts are not normally molded in conjunction with metal powders, but are pressed into place after completion. When a powder metallurgy part is to be used as an insert in a plastic molding, vertical serations parallel to the axis can be molded on the outside diameter. These will serve the purpose of knurling, which would otherwise require an extra operation.

Powdered-metal parts can be machined or ground to maintain closer tolerances, using the same machining procedure as on cast metals. A tungsten carbide tool will provide longer tool life in this operation. Powdered-metal parts will machine much more readily if not impregnated, and a coolant should not be used if the part is to be impregnated after machining.

Some Typical Designs

Cylindrical Parts—An important consideration in the design of sleeve-type parts for powder metallurgy is maintaining a workable relation between the wall thickness on one hand and the length and outside diameter on the other. For a given wall thickness, *e.g.* 0.062 in., there is a maximum length (in this case 1¾ in.) that can be furnished. Similarly a minimum wall thickness of 0.032 in. will be required for a part ¾ in. long; a length of 3½ in. and an outside diameter of 4 in. are the maxima that can be specified if the wall thickness is 0.150 in. Individual powder metallurgy part manufacturers have compiled tables of these relationships for their own equipment and should be consulted on this point. Thin wall sections increase the manufacturing cost and wall sections should therefore be specified as large as is permissible.

Tolerances maintainable are on the order of 0.001 in. per in. on inside or outside diameter and 0.010 in. per 1½ in. in the direction of pressing. Closer tolerances can be maintained but production costs increase in direct proportion to tolerance decrease. A standard eccentric tolerance between i.d. and o.d. is 0.003 in.; closer eccentric tolerances (down to 0.001 in.) may be held but, again, these are more costly.

Flanged Parts—Sharp corners should be avoided at the junction of the flange and the body, since these are difficult to mold and require additional operations. A minimum radius of 0.010 in. should be provided. (See Fig. 3)

The diameter of the flange on a part longer than ¾ in. should not be more than 1½ times its outside diameter. The length of the flange should be tapered 0.001 in. for each ⅛ in. flange thickness to facilitate ejection from the die. Tolerances are approximately the same as for cylindrical parts; 0.005 in. can be held on flange o.d. and flange thickness.

Profiled Parts—All rules for sleeves and flanged parts apply to profiled parts. (See Fig. 6)

Intricate Parts—Powder metallurgy is most often considered as a possible competitor with other methods for the manufacture of intricate parts. It is in this field that the designer must be especially familiar with powder metallurgy's limitations if a practical balance is to be kept between possibilities and costs.

It should be understood that large and abrupt changes in cross-sectional areas cause different rates of expansion in the sintering process, making such parts exceedingly difficult to size, as well as causing surface laminations. Uniform cross sections insure greater strength and reduce production costs. (See Fig. 4)

Parts that have re-entrant angles or curves and undercuts cannot be molded. (See Fig. 5) Depressions, bosses and counterbores should be kept as shallow as possible, with sides tapered to permit easy removal from the die. On a part having a double step, it is necessary for each step to be at least 1/16 in. diameter larger than the body or the preceding step.

Mechanica Properties

The engineer should understand at the start that powder metallurgy materials may not develop as high physical properties by ordinary measuring methods as will many conventionally wrought or cast products. In many cases equivalent tensile strength or ductility is a meaningless requirement from the service point of view, but there are frequent instances where the mechanical properties of powder-pressed parts, especially impact resistance, may be inadequate. The materials should not be specified or purchased on a tensile-strength or hardness basis, however, since the standard tests for these properties do not accurately record their values for powder parts.

The mechanical properties of most pressed and sintered parts depend among other things on their *density,* which in turn is a function of raw materials used and especially of the sintering temperatures and briquetting pressures used. It is thus seen that *both* porosity (for oil-retention or filtering) and maximum mechanical strength are not simultaneously possible, although porous parts do have adequate strength for many types of mechanical service.

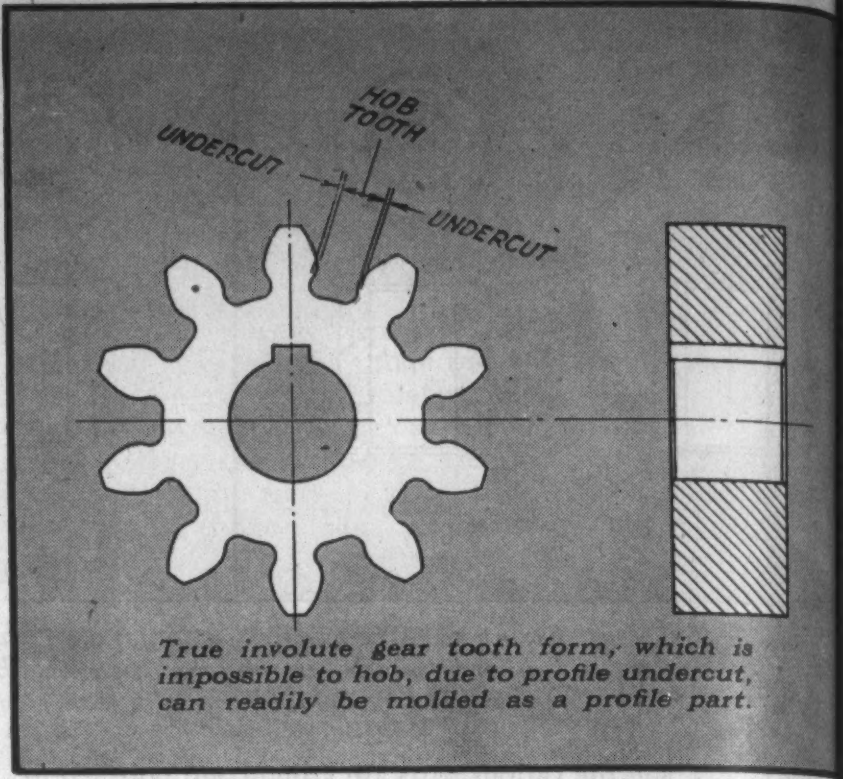

HOB TOOTH
UNDERCUT
UNDERCUT
True involute gear tooth form, which is impossible to hob, due to profile undercut, can readily be molded as a profile part.

Fig. 6. The true involute gear tooth form, which is impossible to hob because of the profile undercut, is typical of a shape ideally suited to powder metallurgy fabrication as a profile part.

The properties of some of the regular grades of controlled-porosity materials in which the authors' company makes machine parts and bearings are presented in the Table as generally indicative of what experienced manufacturers in the industry can do with materials that are not required to be of maximum density. Higher density materials and correspondingly higher mechanical properties can of course also be obtained.

Examples of Successful Applications

The design features of three parts typical of many now being made by powder metallurgy may serve to illustrate some of the principles outlined in the foregoing.

Engineering Properties of Some Powder Metallurgy Materials. (These data are for guidance only; some vdriation may be expected depending on the size, shape, etc., of a particular part.)

PROPERTY	BRONZE (Selflube, grade C-64)			IRON (Selflube, grade F-125)			IRON (Selflube, grade F-200)
	Low	Standard	*High	Low	Standard	*High	*Standard
Ultimate tensile strength (p.s.i.)	10,500	14,000	16,500	12,000	16,000	20,000	40,000
Yield point in compression (p.s.i.) 0.2% offset	8,000	11,000	15,000	21,000	30,000	36,000	50,000
Modulus of rupture (p.s.i.)	15,000	25,000	34,000	25,000	33,000	49,000	70,000
Porosity (%)	29	24	18	34	29	25	24
Apparent density (gms/cc; not oiled)	5.8	6.2	6.7	5.0	5.4	5.7	5.9
Electrical resistance (microhm-cm.)	39	34	29	50	37	33	25
Chemical composition	88–92% Cu 8–12% Sn			92–98% Fe 3– 8% Cu			87–93% Fe 8–13% Cu
Melting point, deg. F.	Above 1500			Above 2300			Above 2300
Wear resistance	Good			Good			Good
Resistance to seizure and galling	Good			Good			Good
Corrosion resistance	Excellent			Fair to Good when Oiled			Fair to Good when Oiled
Machinability	Fair (Dry with carbide tools)			Fair (Dry with carbide tools)			Fair (Dry with carbide tools)

* *These properties may not be obtainable in certain parts because of limitations imposed by size, shape, etc., and where available involve an increase in price.*

(1) Roller for machine gun mounts

This part (See Fig. 7) was previously made from steel, hardened and cadmium plated. A self lubricating bearing was then pressed into the center hole.

In the application of this part, three of the rollers, equally spaced, ride on the outside of a V slot cut on the o.d. of the machine gun base. These three rollers support the entire load of the gun and must rotate smoothly with light pressures, as the entire aiming of the gun is dependent upon how free the movement is.

In the previous design, adjusting nuts were necessary on each roller, to compensate for the variation in concentricity and to prevent binding. It took an inspector from three to fifteen minutes to adjust all three rollers to provide free movement of the gun. This type of roller had a tendency to go out of alignment with every bump or jar, necessitating additional adjustments.

These rollers are now being made of porous bronze (Selflube grade C-64). They are now maintained to such close tolerances on size and concentricity, that the adjusting nuts are no longer necessary. The rollers provide the necessary free and even movement without any subsequent adjustment. This represents a production saving of approximately 9 min. on each gun mount as well as an insurance against any further misalignment in service.

(2) Base cover plate for solenoid

This part, used in gas tanks of airplanes, was formerly made of steel and required many hours of machining and drilling. The peculiar application required that the part be non-porous and able to withstand pressure without leakage. The part is now being made from iron powder (Selflube grade F-125) treated to seal the pores. The tooling-up job required less time than by other methods and production is now approximately three times what it formerly was, while the cost of the part has been greatly reduced. (See Fig. 8)

(3) Valve guide

This part (See Fig. 9) is used as a valve guide in an internal combustion engine. The application requires that the valve guide be able to operate for a minimum of 500 hr. at temperatures of 800 F., without lubrication and at the same time provide free and easy movement of the valve without sticking, gumming or binding. No provision can be made for lubrication and the valve guide must provide its own.

Previously various types of valve guide material were tried, but the valves would stick after 50 to 75 hr., freezing the motor. It would then be necessary to dismantle the motor, remove the valve guides as well as valves, and replace them.

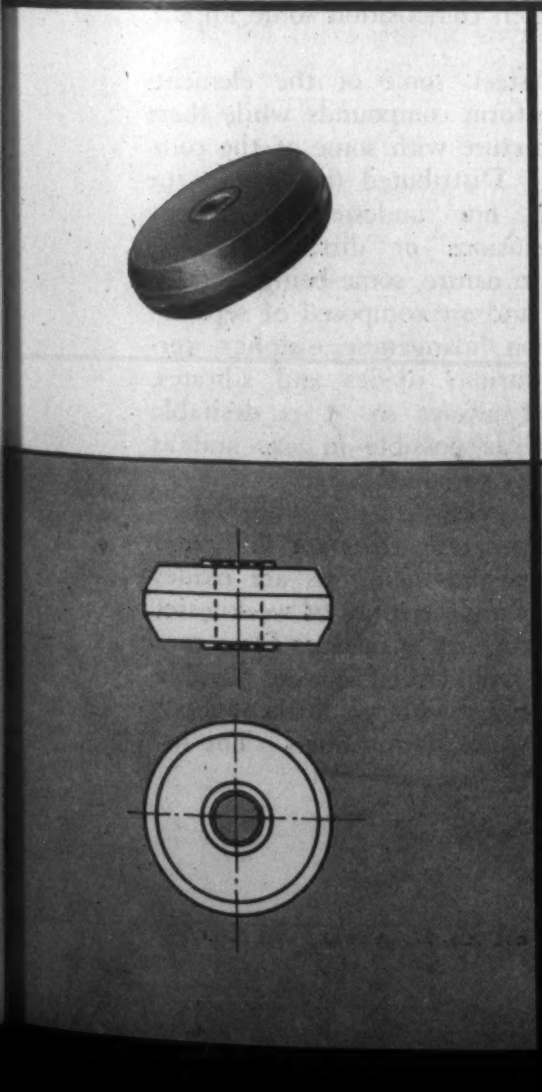
This part is now being made by powder metallurgy out of a brass powder combination with a large percentage of graphite (Keystone grade D-10). This fine graphite is not placed in the brass after molding but is evenly mixed with the brass powder before molding, thereby guaranteeing uniformity of dispersal throughout the entire part. This powder metallurgy valve guide now provides trouble free performance for more than the 500 required hours.

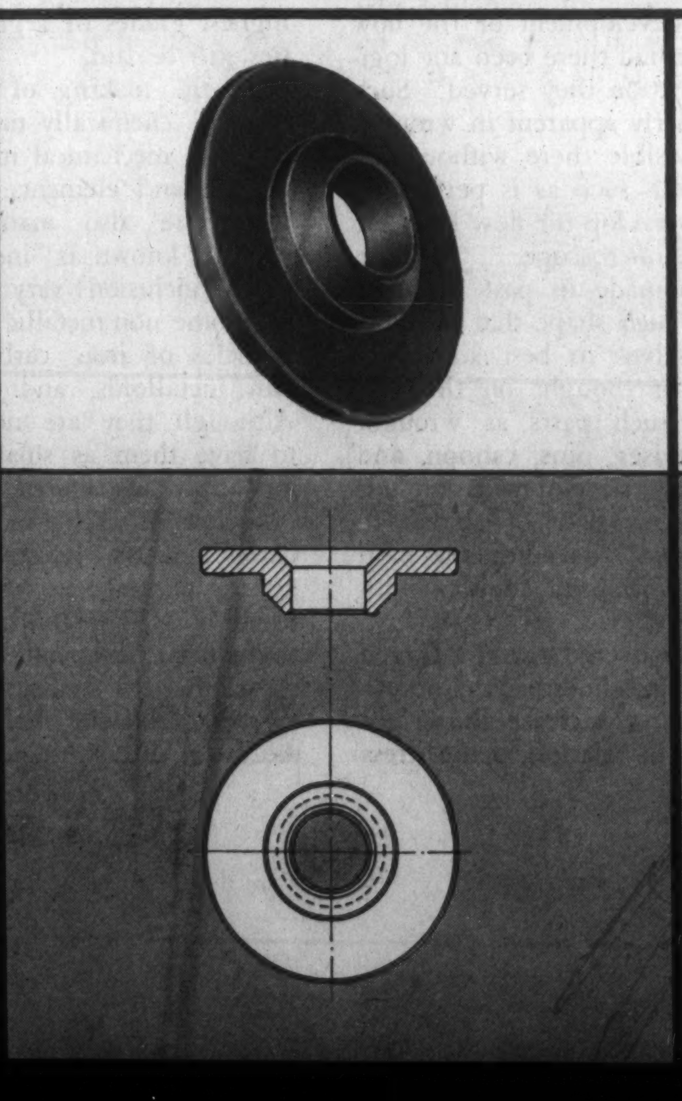
The limitations outlined in this article are those that apply to methods that have been tried and proven in production up to the present time. Technical advances are being made constantly and process improvements evolved in the industry's laboratories that may overcome some of the existing limitations, and the outlook is promising, indeed.

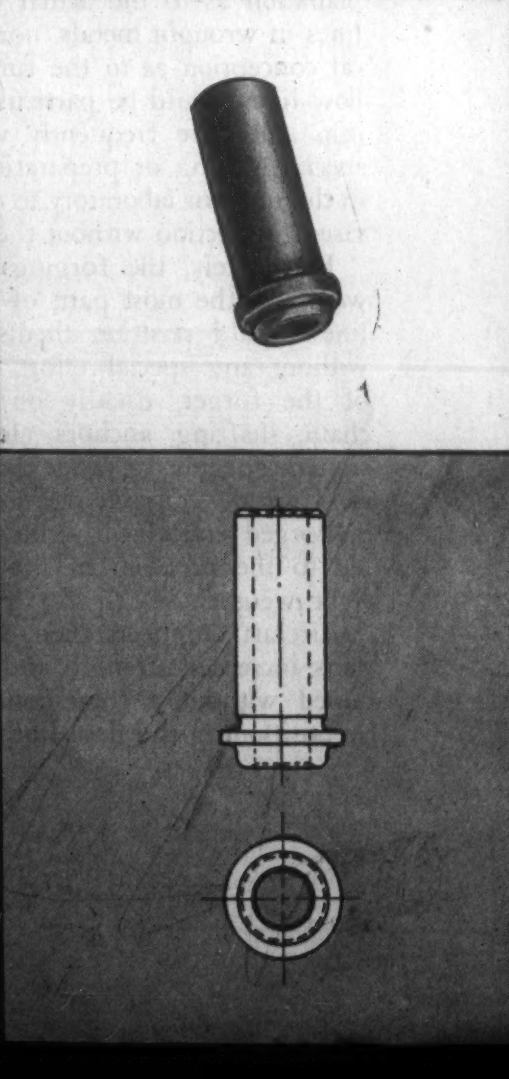
Fig. 7 (left). A roller for machine gun mounts, whose manufacture as a bronze powder metallurgy part is saving considerable production time.

Fig. 8 (center). Improvement in cost and in output followed conversion of this part—a base cover plate for an aircraft engine mixing valve—from machined steel to pressed iron powder.

Fig. 9 (right). The valve guide for an internal combustion engine shown here is a graphited brass powder metallurgy part and gives several hundred per cent longer life than when made of former materials.





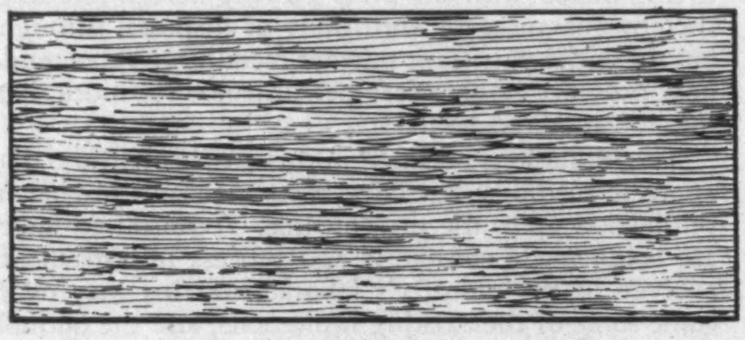


Planned Grain Flow in Forgings

by WALDEMAR NAUJOKS

Chief Engineer, The Steel Improvement & Forge Co., Cleveland

In this brief explanation of the origin and development of the flow lines or fibre structure to which forgings owe so much of their high strength and serviceability, Mr. Naujoks stresses the importance of designing the part and planning the forging operation so that optimum positioning of the grain flow will result. —*The Editors*



Flow lines in opened forging stock.

THE PHENOMENON OF GRAIN FLOW, or flow lines, in wrought metals, particularly in forgings of iron and steel, has been known for many centuries. It has been always associated with the strength and toughness of these forgings, but for a long time there had been no satisfactory understanding or explanation as to the actual development of the flow lines in wrought metals, nor had there been any logical conception as to the function they served. Such flow lines would be particularly apparent in wrought iron and were frequently visible there without any special etching or preparation, such as is performed in the modern laboratory to develop the flow lines for visual inspection without the microscope.

Fortunately, the forgings made in past centuries were, for the most part, of such shape that the flow lines would position themselves to best advantage without any special effort or thought on the part of the forger, usually on such parts as wrought chain, shafting, anchors, clevises, pins, cannon, and similar forgings. The rapid development of our mechanical era increased the variety of shapes to be forged and the invention of the aeroplane soon led to the problem of high strength coupled with light weight.

Aircraft engineers then discovered that in forged parts increased strength and toughness could be obtained without a corresponding increase in weight by positioning the flow lines in relation to the stress direction and they were quick to make use of this knowledge. However, there was as yet no certainty as to the exact nature of the fibre structure and this problem led to a metallurgical study of grain flow to determine what it is and why wrought metals should offer high strength, stamina, and wearing properties to live loads when the fibre structure was properly positioned.

Metals As-Cast

The inception and development of flow lines in the wrought metals is the product of two actions, one chemical and one mechanical. The general actions can be outlined without a detailed description of the chemical or mechanical actions. Everybody knows that all wrought metals receive their compositions by producing the analysis in the form of a casting, and the castings prepared for subsequent mechanical working are usually termed "ingots." It is also known generally that even in a laboratory it is difficult or even impossible to produce compositions that do not contain a small percentage of impurities or substances not desired in the melt. The difficulty in keeping out the impurities on a commercial production basis is increased by many times. It is recognized that all commercial compositions contain a small amount of impurities. Even in the highest grades of a given composition some impurities still remain.

In the making of steel, some of the elements combine chemically to form compounds while there is also a mechanical mixture with some of the compounds and elements. Distributed throughout the ingot are also many fine undesirable impurity particles known as "inclusions" or "dirt."

The inclusions vary in nature, some being metallic and some non-metallic and are composed of separate particles of iron, carbon, manganese, sulphur, certain metalloids, and various oxides and silicates. Although they are not always so, it is desirable to have them as small as possible in size and as uniformly distributed as possible.

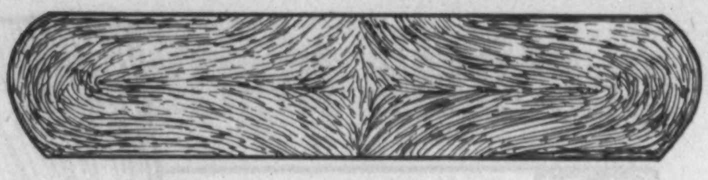
Inclusions are present between the grain boundaries and are weaker generally than are the metal grains, particularly when the inclusions are oxides or silicates. They impart minute zones of weaknesses throughout the metal structure. Consider for a moment what the structure would be if it were possible to replace all the inclusions with voids throughout the metal, leaving a network of tiny holes. The inclusions do have some strength and the condition is not as extreme as the void network just described, but the analogy pictures the general effect of inclusions in steel.

Metal, in the cast form, is considered to be as strong in one direction as it is in any other direction in resisting service stresses—and if the casting contains no blowholes or segregation, this is usually true. A cast ingot that shows signs of pronounced segregation or excessive size of inclusions is subject to rejection. For the higher quality steels such as aircraft or rifle barrel quality, a closer tolerance is used on the permissible amount of impurities or on the size of non-metallic inclusions.

Development of Flow Lines

The steel ingot, upon solidification, is subjected to hot mechanical working at a temperature which puts the metal in its best plastic state, and the cogging and rolling temperatures are usually over 2000 deg. F., well above the recrystallization temperature and 'way above the critical range. At high recrystallization temperatures the grain structure attempts to revert to its normal undeformed state during the hot working operations, doing this almost as fast as it is being deformed by the hot working. The result is that after the steel has been worked from the cast ingot to the finished billet or bar by a series of hot-rolling operations, the crystalline structure of the metal undergoes no appreciable distortion of grain structure or deformation such as that shown by cold working operations.

It is also known, however, that hot mechanical working such as rolling and forging tends to break up the grain size faster than the grain growth taking place, so that at the finish rolling temperature, which is considerably below the initial rolling temperature, the grain structure is usually smaller than it was in the original cast ingot. Rolling and forging also break up dendritic cast structure.



Grain flow in a pancake biscuit.

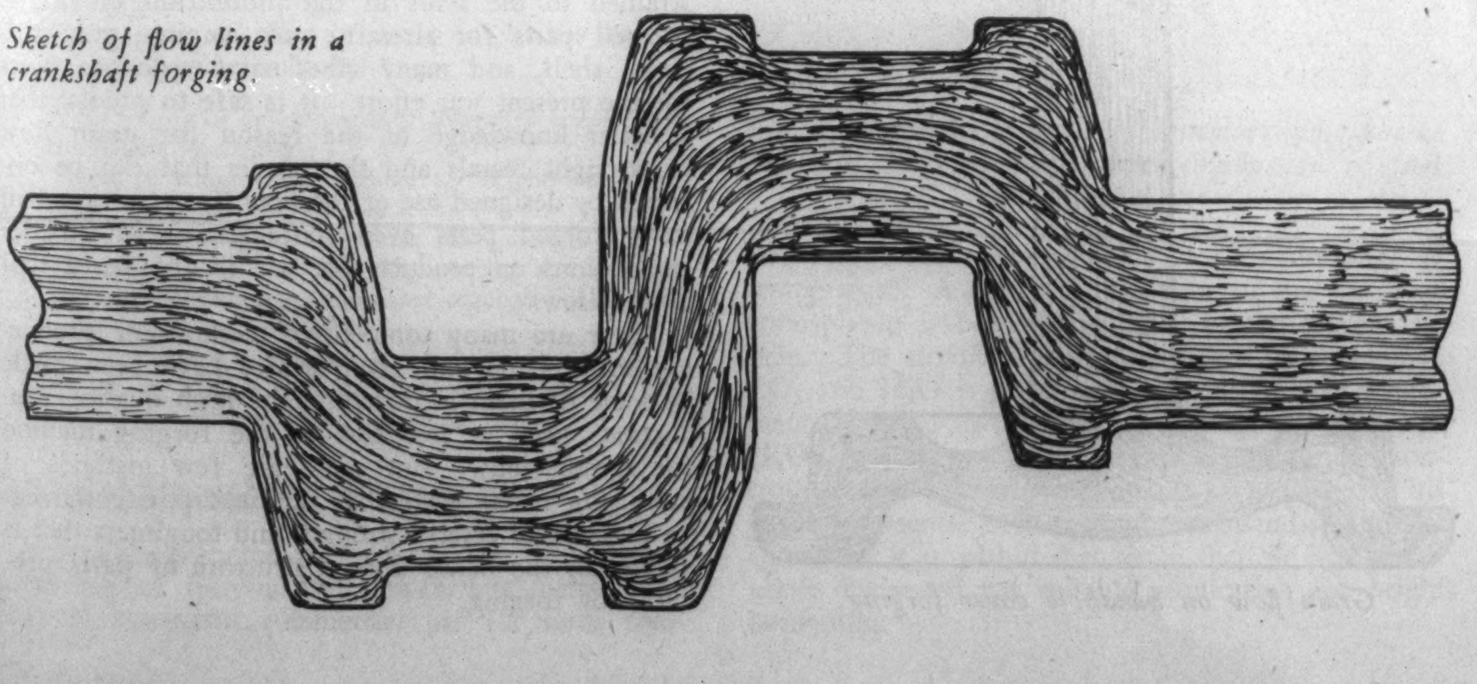
During the series of cogging and rolling operations, starting from the cogging of the ingot and following through the series of rolling operations in which the original cross-section is considerably reduced, the inclusions are drawn out into long hairlike stringers. These inclusions do not revert to their original shape or size since they are not affected by heating or cooling in the manner that the steel crystals are. The result is the fibre structure in wrought metals, which appears to be similar to grain structure in wood. Non-ferrous metals contain similar inclusions and offer similar properties in wrought and forged parts.

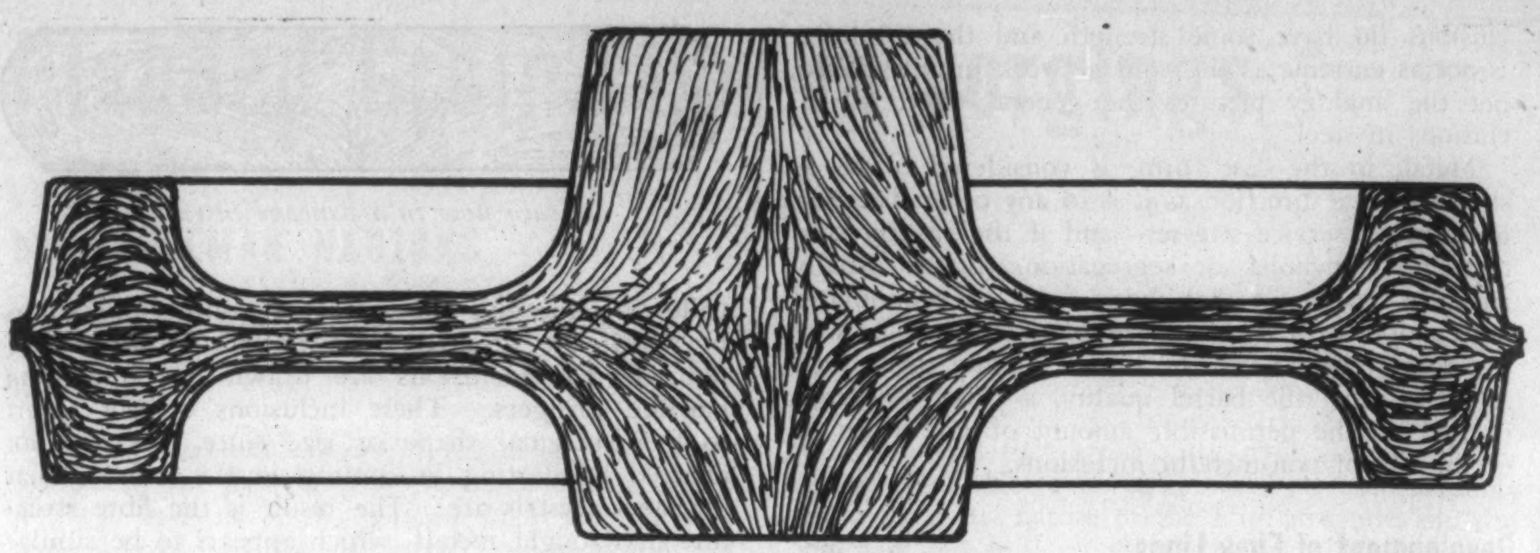
Since the fibre structure or flow lines in wrought metals are known to be in the direction of working, the flow lines in rolled billets are parallel to the length of the bars, and the billets and bars to be used as forging stock can be cut to suit the forging operation. The position of the flow lines in forgings depends upon the positioning of the forging stock in the initial forging operation and upon the design of the subsequent sequence of forging steps in flowing the metal to the final shape.

The forging stock can be placed in between the forging dies so that the flow lines in the forging stock are horizontal with the dies, that is, parallel with the die faces. In the horizontal position the flow lines may be positioned parallel to the length of the dies or at right angles to the length, or at some desired angle in between. The forging stock may also be set up-end on the dies so that the flow lines are in a vertical position. The exact initial positioning and the subsequent forging operations depend upon the shape and complexity of the forged part and upon the direction of the important stresses on the part when in service.

It is general practice today to specify grain flow

Sketch of flow lines in a crankshaft forging.





Flow lines in a finished forged blank.

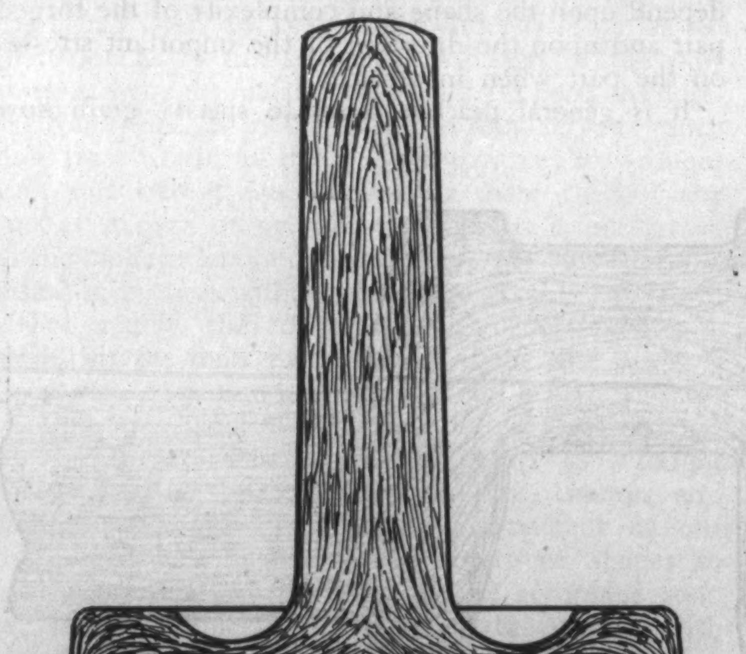
position after a stress diagram has been made and this practice determines grain flow position for all aircraft parts including motor parts, fuselage fittings, landing gear forgings, and other highly important aircraft forgings.

Strength Ratios

In the final analysis, it is the results in service tests that are determining factors, and while forgings have a sort of mystery about them even to many today, their unusual strength and stamina for unpredictable stresses lies in the flow lines. Tensile tests have indicated that the tensile and yield strength between specimens taken in the longitudinal position and those taken in the transverse position are about the same. In the figures on reduction in area and in elongation there is a considerable difference.

The reduction in area value for the longitudinal direction is about two times greater than values for the transverse specimens. Similarly, the percentage of elongation on longitudinal specimens is about one and one-half times greater than values for transverse specimens. This would indicate that for general static loads the position of the flow lines is not so important as flow-line position for parts under live loads.

The important test that emphasizes the controlling nature of grain flow positioning is the notch impact test, which indicates the toughness of the material. Average figures indicate that the impact strength or toughness is about three times greater for impact specimens taken in the longitudinal direction over those taken in the transverse direction. This indicates without question the importance of flow-line positioning on parts subjected to impact, shock, vibration, stress concentration, or where unexpected stresses may be encountered. For live or shifting stresses, accurate grain flow positioning can be determined from stress diagrams.



Grain flow on handhole cover forging.

Conclusion

The ability of forgings to supply that extra reserve strength in emergencies is traditional. That is the reason the forging capacity of this country is being strained to the limit in the production of highly stressed parts for aircraft, tank, engine, gun, torpedo, shell, and many other vital ordnance parts for the present war effort. It is safe to predict that a better knowledge of the reason for grain flow in wrought metals and the results that can be obtained by designed use of the flow line structure will make forged parts even more useful in broader applications on products for use in the peace that is to follow.

There are many competitive methods of producing metal parts and great strides have been made by some of them in matching the high quality, production speed or low cost of the forging method for certain jobs. But there are few methods of producing metal parts that can incorporate the extra measure of reserve strength and toughness that is packed in the dense fibrous structure of parts produced by forging.

Controlled Atmospheres for Bright Hardening

Numerous atmospheres have been developed to prevent the scaling or decarburization of steel during heat treatment and thereby to obviate subsequent expensive and time-consuming cleaning, pickling or grinding operations. Few have been successfully and broadly applicable to steels of widely varying carbon or alloy content or temperature conditions. The author discusses the fields of use of some of the most useful varieties, with particular attention to separately prepared completely reacted fuel gas atmospheres.
—*The Editors*

By C. E. PECK

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THE HARDENING OF METALS by heat treatment presents a very broad field of modern engineering. The development of numerous new alloys which require very careful control of the many variables associated with temperature and quenching has added many new and interesting problems. One of the important phases of this problem deals with the surface condition of the steel being hardened with particular attention given to close control of decarburization or carburization together with the attainment of a clean, scale-free surface.

Important developments in the application of separately produced controlled atmospheres for use in heat-treating furnaces now make it possible to harden intricate machine parts without decarburization or oxidation of the surfaces. This close control of surface conditions, which eliminates soft skin and scale on the piece being hardened, makes unnecessary the need for finish machining or grinding operations and also eliminates the necessity for cleaning or sandblasting or de-scaling.

The purpose of this article is to discuss briefly the following principal points:

1. Brief history of development of controlled atmospheres for bright hardening.
2. Types of atmospheres suitable for bright hardening, chemical composition and cost.
3. Equipment for producing these atmospheres.
4. Discussion of equilibrium requirements and practical ways of determining atmosphere required for a given steel at a given temperature.
5. Types of steels which may be bright hardened.
6. Types of furnace equipment most suitable for controlled atmosphere bright hardening.

Controlled Atmospheres in General Use

Separately prepared atmospheres for use in bright annealing of ferrous and non-ferrous metals have been in successful commercial use for some time. These atmospheres were produced by partial combustion of fuel gases under controlled conditions. The range of composition of these bright annealing atmospheres is illustrated by the chart shown in Fig. 1. The right-hand side of the chart near the region of complete combustion gives gas compositions generally used for bright annealing of copper. The center portion of the chart gives gas compositions generally used for bright annealing of steel below the critical range. These gases contain appreciable carbon dioxide (CO_2) and water (H_2O), both of which are actively decarburizing to steels in the region of or above the critical.

If all of the CO_2 and H_2O is thoroughly removed from these gases, they are quite suitable for bright annealing or bright hardening without decarburization for a wide range of steels over a wide range of temperature. A complete discussion of this range of atmospheres is beyond the scope of the present article. The auxiliary equipment necessary to remove CO_2 and H_2O is much more expensive than equipment designed to completely react out the CO_2 and H_2O from the air-gas mixtures heated under controlled conditions in the presence of a catalyst. This gas is represented at the extreme left-hand side of the chart and it is within this range that we are particularly interested for suitable application for bright hardening.

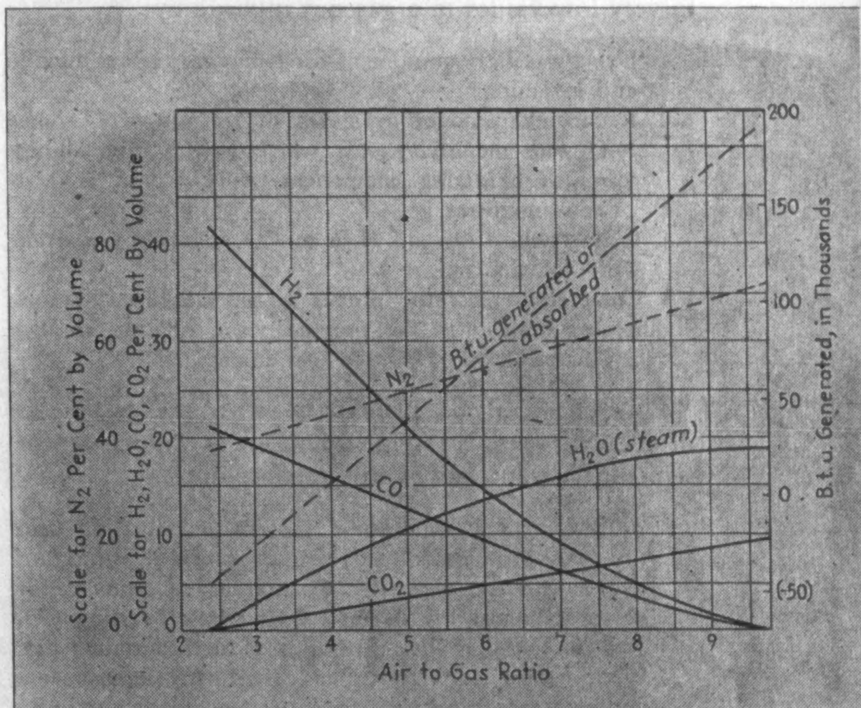


Fig. 1. Composition of bright annealing atmospheres produced by controlled partial combustion of fuel gas (methane).

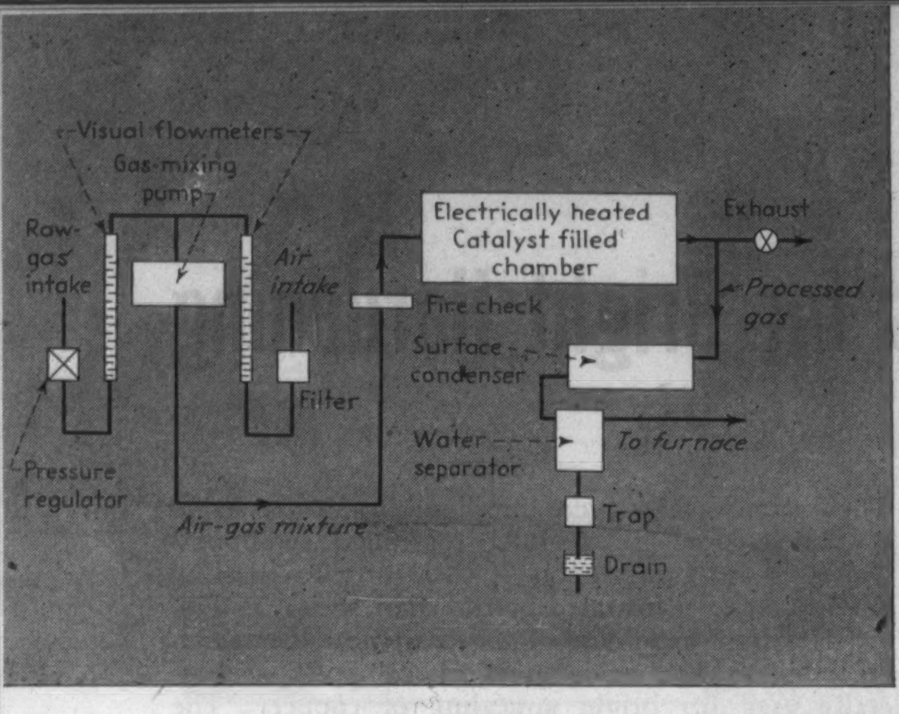


Fig. 2. Schematic arrangement and flow diagram of gas generator.

The experiences gained over the past several years in the development of atmospheres suitable for bright hardening have shown conclusively that the atmosphere required, if decarburization is to be prevented, must be very low in CO_2 and H_2O no matter how it is produced and no matter what source of fuel is used. Now CO_2 and H_2O can be reduced to very low values in a gaseous mixture by:

1. Using auxiliary equipment for removing carbon dioxide and moisture.
2. Reduce the amount by means of reaction of CO_2 and H_2O with metallic vapors which have a high affinity for such oxidizing components as CO_2 and H_2O in gaseous mixtures.
3. Convert the CO_2 and H_2O to CO and H_2 by reaction with hot charcoal.
4. Completely react the proper air-gas mixtures by controlled heating in the presence of a catalyst, so that residual CO_2 and H_2O are very small.

This article deals principally with the successful commercial application of Method 4. Some of the particular advantages of this method are:

1. The controlled atmosphere is economically and continuously produced direct from a fuel gas—air mixture eliminating the necessity for auxiliary equipment for either removing or further reacting or converting CO_2 and H_2O so that they do not exist in the product gas.
2. It can be used directly in standard furnace equipments designed for heat treatment with a separately produced atmosphere, since special muffles are not required.
3. By means of simple adjustments it can be set to approximate chemical balance with the surfaces of a wide range of carbon contents in steels heat treated over a wide range of temperatures so that decarburization and oxidation do not occur.

As an example of a protective atmosphere produced by complete reaction, the chart shown in Fig. 1 in the region of the extreme left-hand side gives a picture of the composition of this gas. The reactions which take place to produce this gas, assuming methane as the fuel gas, are as follows:

$$CH_4 + \tfrac{1}{2} O_2 + 1.88N_2 \rightarrow CO + 2H_2 + 1.88N_2$$

The end product contains small amounts of carbon dioxide (CO_2) and water vapor consistent with the laws of mass action and equilibrium fundamentally related to the production of any gas. Since this gas is produced at high temperatures and is to all practical purposes in equilibrium, there is very little change in composition of the gas when used in furnace equipment unless considerable impurities are allowed to enter into the furnace during handling of the work.

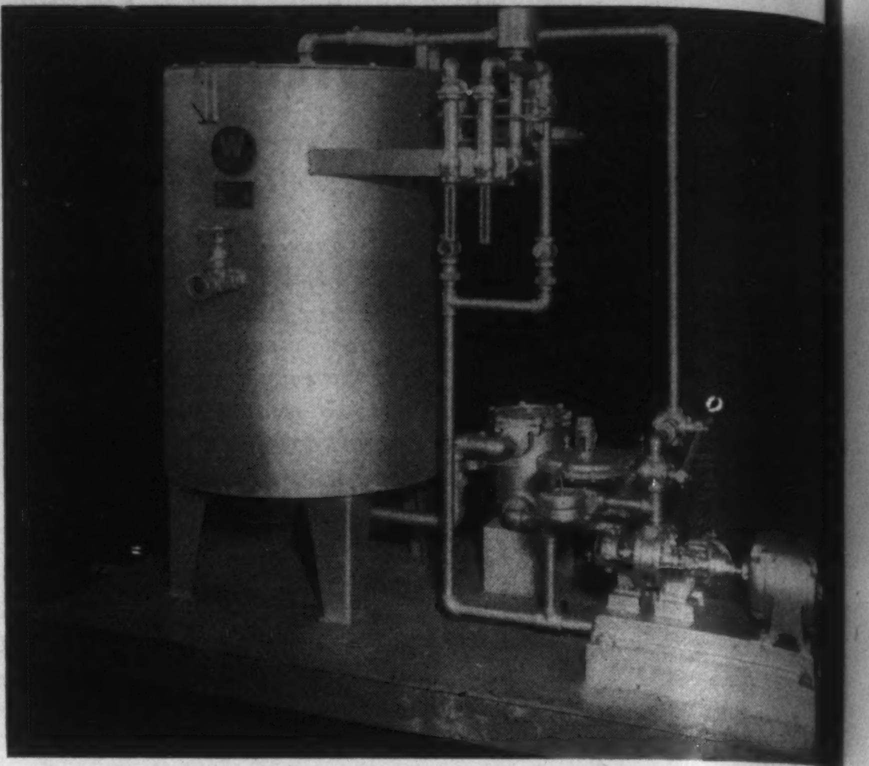


Fig. 3. An Endogas atmosphere generating unit.

A schematic flow diagram of the equipment used to produce the completely reacted gas (termed "Endogas" since heat is required to complete these reactions) is shown in Fig. 2. A gas mixing pump draws air through a filter and the air flow automatically regulates the flow of gas to give a pre-determined air-gas ratio. The air and gas after flowing through are mixed together at a point preceding the pump visual flowmeters which indicate the air-gas ratio inlet. The pump moves the air-gas mixture through a piping system and firecheck to an electrically heated catalyst-filled chamber and in this chamber the reaction of the air-gas mixture takes place to produce the gas shown on the left-hand side of the chart.

With methane as the fuel this gas consists of approximately 40 H_2, 20 CO, 0.50 methane (CH_4) and 0 per cent CO_2, a dewpoint of —10 to —15 deg. F., the balance nitrogen. The gas leaving the catalyst-filled chamber is quickly quenched in a surface condenser and a water separator is also provided for those applications where it is desired to operate the equipment at a leaner mixture of air-gas which will produce some water vapor. A photograph of this equipment is shown in Fig. 3. The average cost of this gas using commercially available fuel gas as a source, varies from 18 to 25c per 1000 cu. ft. of produced gas.

"Balance" of Atmosphere with Steel Surface

The "idealized" solution to the problem of hardening a piece of high carbon or alloy carbon steel without decarburization, carburization, or oxidation is to surround the piece at its hardening temperature with an atmosphere which is in chemical equilibrium with the carbon content of the steel and which will not oxidize the surface. In general, long experience has shown that an atmosphere which is close to being in equilibrium with the steel at hardening temperatures is always non-oxidizing so that the problem of oxidation can be eliminated entirely except on the high-chromium stainless steels. The problem can therefore be limited to preventing surface changes in carbon content.

In order to obtain equilibrium on the surface of the steel several conditions of gas-metals reactions must be simultaneously fulfilled. A brief reference is given to these reactions in order to point out the need for a simple means of evaluating when an atmosphere is at or near equilibrium with the carbon in the surface of the steel.

Carburization and decarburization of steel may be shown by the reaction:

$$Fe_3C + CO_2 \rightleftarrows 3Fe + 2CO$$

consisting of 2 separate reactions

$$Fe_3C \rightleftarrows 3Fe + C \quad (1)$$

and

$$2CO \rightleftarrows CO_2 + C \quad (2)$$

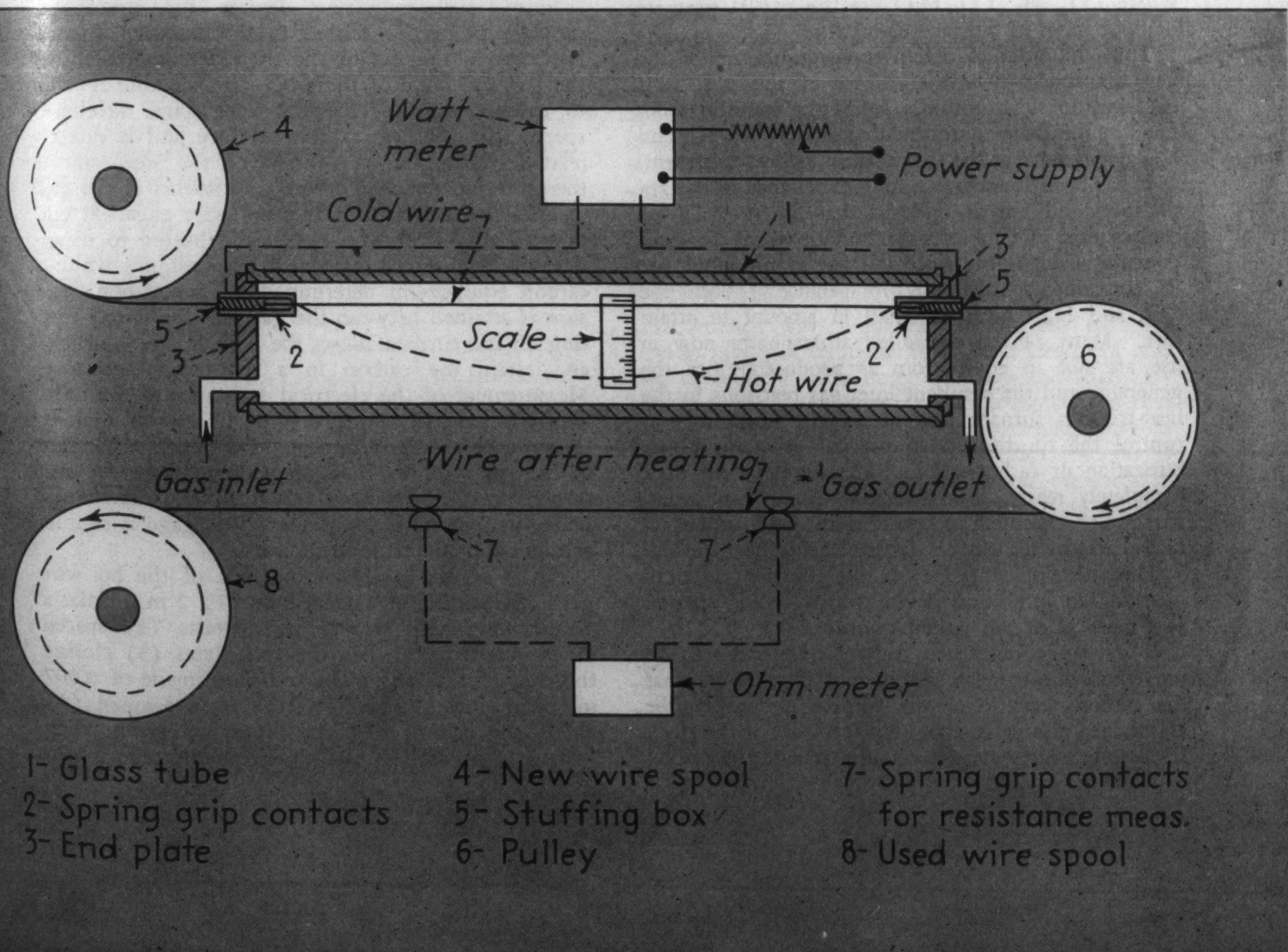
The Fe_3C behaves as a solid solution of iron and carbon and it is assumed that a very small carbon vapor pressure exists which is directly related to the amount of carbon in the steel and to the temperature. It is also assumed the carbon resulting from the dissociation of CO over the surface of the steel exerts a carbon vapor pressure which is related to the relative concentration of CO and CO_2 in the gas. The magnitude of this carbon pressure in the gas is related to equilibrium constant of reaction (2) according to the mass action law and may be expressed at a given temperature as $K_2 = \frac{(CO)^2}{CO_2}$ where CO and CO_2 represent partial pressures of these gases in the gas atmosphere used.

Another important carburization and decarburization reaction is represented by:

$Fe_3C + 2H_2 \rightleftarrows 3Fe + CH_4$ consisting of the separate reactions $Fe_3C \rightleftarrows 3Fe + C$ (3) and $CH_4 \rightleftarrows 2H_2 + C$ (4)

As assumed above for reactions (1) and (2) the carbon resulting from the dissociation of CH_4 over the surface of the steel exerts a carbon vapor pressure which is related to the relative concentration of H_2 and CH_4 in the gas and the magnitude of this carbon pressure in the gas is related to the equilibrium constant of reaction (4) according to mass action law and may be expressed at a given temperature as $K_4 = \frac{(H_2)^2}{CH_4}$ where CH_4 and H_2 represent partial pressures of these gases in the gas atmosphere used.

Fig. 4. Schematic sketch of the hot wire gage.



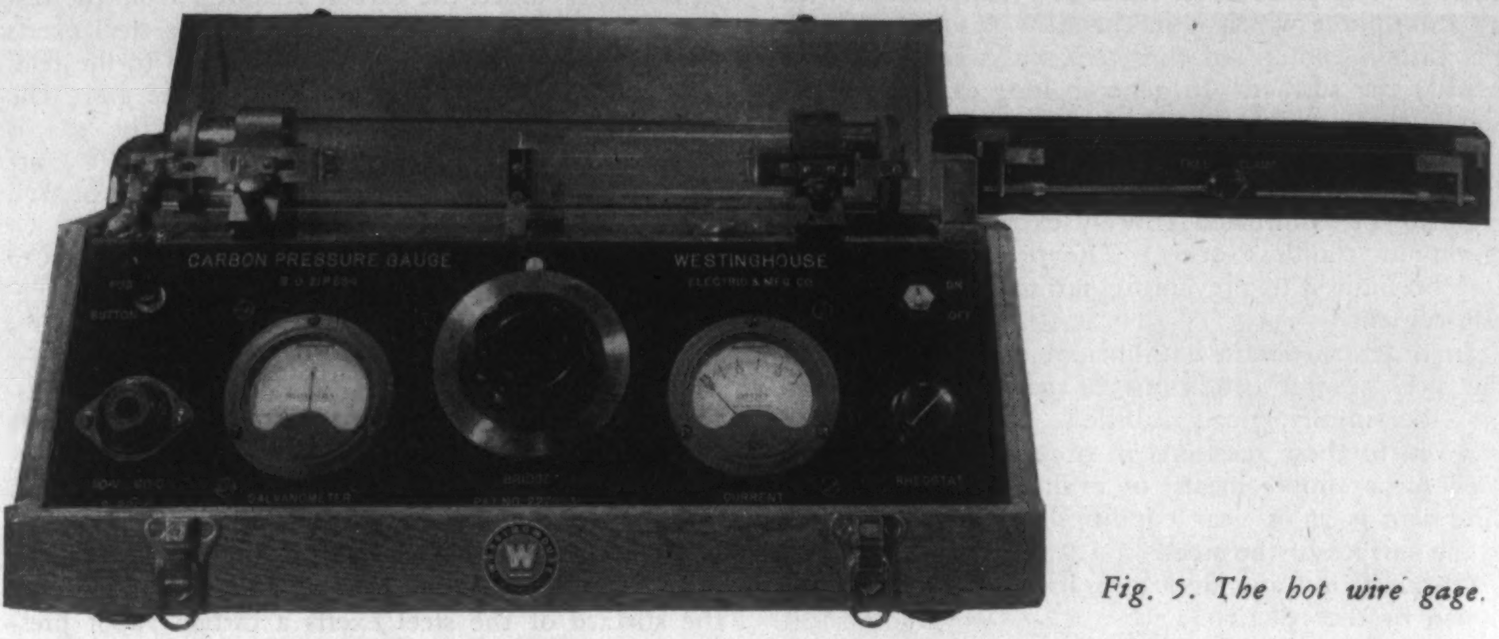


Fig. 5. *The hot wire gage.*

A third important factor is interaction between components in the gas atmosphere itself as represented by the reaction (the "water gas" reaction):

$$CO_2 + H_2 \rightleftarrows CO + H_2O \quad (5)$$

According to the mass action law the equilibrium constant at a given temperature for this reaction can be expressed by:

$$K_5 = \frac{CO_2 \times H_2}{CO \times H_2O}$$

where CO_2, H_2, CO, H_2O are the partial pressure of these gases in the gaseous mixture.

Thus, in order to obtain true equilibrium of the gas atmosphere over the surface of the steel it is necessary to simultaneously fulfill the conditions defined by the three equilibrium constants[1], K_2, K_4, and K_5, given above at the temperature of heat treatment.

It has been found from long experience in the application and use of Endogas that the shift in gas composition due to inter-reaction between the components is negligible since the gas as produced has its components inherently in balance. Both the CO_2 and H_2O must be small in amount to attain this. Many of the controlled atmospheres now in use are not in equilibrium as produced from the generator and the resultant inter-gas reactions in the heat-treating furnace make it almost impossible to control the constituents to prevent excessive decarburization or carburization. The development of a completely reacted gas eliminates this variable and narrows the problem of equilibrium down to the actual effects of the gas on the steel being heat treated.

This development led to the further development of an indicating device which could be used as a measure of the carbon pressure.[2]

If a change in carbon content of steel is to be prevented during heat treatment it is necessary that the carbon pressure of the furnace atmosphere be maintained at a value about equal to that of the steel. If these pressures are not equal, a transfer of carbon will occur from the element having the higher carbon pressure to the element having the lower carbon pressure *e.g.*, carbon from steel to the gas is decarburization. The *rate* of carbon transfer between the steel and the atmosphere surrounding it is a function of the difference between these carbon pressures, the temperature, and the rate at which carbon will enter or leave the surface of the steel at this same temperature.

The Hot Wire Gage

Since most indicating devices for atmosphere measure properties related to the amount of combustibles in the gas or the thermal conductivity of the gas and none of these bear any definite relation to carbon pressure, the hot wire gage developed specifically measures carbon pressure and is directly related to the carbon content of the steel and is therefore independent of the constituents in the gas.

This device is known as a hot wire gage. It employs a thin steel wire electrically heated to incandescence in the test gas for a few minutes while a carbon equilibrium determined by gas carbon pressure is attained between the gas and the wire. Cutting off the current allows the wire to "gas quench" and retain the carbon in a martensitic structure. Measurement of the electrical resistance of the wire, which is a sensitive function of its carbon content, then can be used as a measure of the carbon pressure of the gas after the relation between resistance and carbon pressure has been experimentally determined under standardized conditions. This gage is simple, accurate and adaptable to shop use.

Fig. 4 shows a schematic sketch of the hot-wire gage. It consists of a glass tube (1) 2 in. in dia. x 14 in. long with two spring contacts (2) spaced 12 in. apart mounted in the end plates (3) closing the ends of the tube. The test wire, made of 0.007 in. diam. low carbon steel, fed from a spool (4) enters one end of the tube through a stuffing box (5), a 12-in. section of the wire in the tube is suspended between the two spring contacts. The wire passes out the opposite end of the tube through a second stuffing box (5); it goes over a pulley (6), then back through the spring contacts (7) and is finally wound on the spool (8). A vertical metal scale is placed at the center of the tube close to the plane of the wire to measure its sag.

A power source of adjustable voltage is connected through a wattmeter to the section of wire suspended in the glass tube between the electrodes. An ohmmeter is connected to the external contacts—to measure at room temperature the resistance of the section of wire stretched between them.

To use the gage a small flow (5 cu. ft. per hr.) of the gas to be tested is passed through the glass tube. The wire is heated to some arbitrarily chosen temperature above 1700 deg. F. applying the necessary wattage to it. After 10 min. at temperature in the gas the power is shut off and the portion of the wire that had been heated is advanced to a position between the external contacts where its resistance is measured at room temperature. The gage wires used for these experiments were plain low carbon steel containing 0.5 per cent Mn.

It is possible with this type of instrument to evaluate the carbon pressure of the gas atmosphere at various heat-treating temperatures and correlate these values of carbon pressure with the equilibrium carbon content of the steel over a wide range of carbon content.

In order to do this the carbon pressure as measured on the gage with a given gas composition is compared with the carbon content of the steel at a given temperature over which is passed the same gas for a sufficiently long period to reach equilibrium. In other words, if the steel contained more carbon and therefore a higher carbon pressure in the gas surrounding the steel, it would be decarburized until the carbon pressure of the steel is equal to the carbon pressure of the gas. If the carbon content of the steel is carefully measured both before and after such a test, it is possible to accurately evaluate the actual carbon content of the steel and to correlate this value with the resistance of the hot wire as measured in the hot wire gage with the same atmosphere.

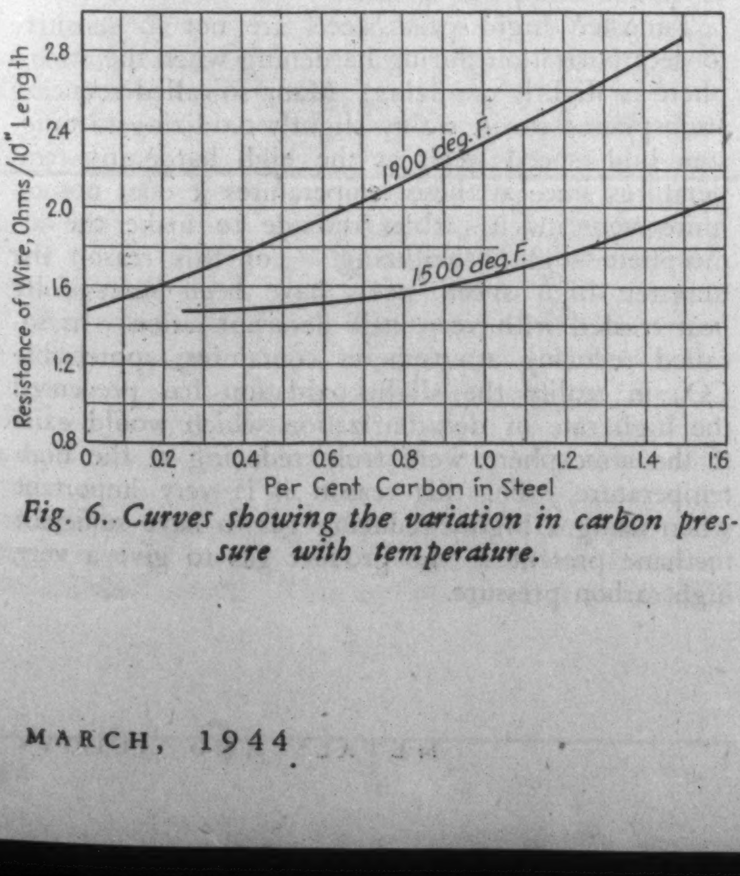


Fig. 6. Curves showing the variation in carbon pressure with temperature.

Changes in Temperature and Carbon Content

A summary of the results of such an investigation at various temperatures is shown in the curves of Fig. 6. These curves are of considerable interest since it is possible to obtain from them a relative idea of the carburizing or decarburizing power of the atmosphere at various temperatures and the function of the carbon content in the steel. For instance, from the curve at 1900 deg. F. a gas atmosphere surrounding the steel which would give a resistance of 1.7 ohms on the hot wire gage will be in equilibrium with a steel of approximately 0.3 per cent C. At this same resistance therefore with the same gas surrounding the steel at 1500 deg., this same gas would be in equilibrium with a piece of steel containing 1.1 per cent C.

The reason for this is that the carbon pressure of the gas remains constant due to the continuous flow of new gas into the furnace while the carbon pressure of the steel depends almost entirely on the temperature surrounding the steel and the composition of the steel. Therefore the rate of escape of carbon would be much more rapid at 1900 deg. F. than say at 1500 deg. F. for any steel of a definite carbon content. These curves also show that the carbon pressure of a low carbon steel at a high temperature is equal to the carbon pressure of a steel of higher carbon content at a low temperature.

The data shown in the curves are based on an investigation using plain carbon steels. The actual rates of decarburization or carburization and the equilibrium carbon contents of the various alloy steels are not necessarily quite the same as those for straight carbon steels. However, these carbon pressures shown on the curve are still a valuable guide for determining the relationship between the probable carbon pressure required in the atmosphere for a given carbon content in the steel, as related to the hot wire gage reading. Since the rates of carbon loss from the surface are relatively much slower at the lower temperatures, it is possible to use a gas with a wider latitude of carbon pressure than it would be for steels requiring much higher heat-treating temperatures.

Types of Steels for Bright Hardening

Experience with numerous installations covering a wide range of temperature of heat treatment and also covering a wide range of alloy and high carbon steels has proven that a completely reacted fuel gas is very suitable for bright hardening without oxidation or decarburization. Because the gas is easily adjusted to give various carbon pressures as described in the previous paragraphs, it is capable of bright hardening over a wide range of temperature without excessive carburization or decarburization.

In general for the large group of steels of the alloy type which are hardened in the neighborhood of 1450 to 1550 deg. F., the carbon pressures of the gas do not need to be nearly so high as for the more special steels requiring much higher hardening temperatures. In these lower temperature ranges it is also practical to heat treat with a wider

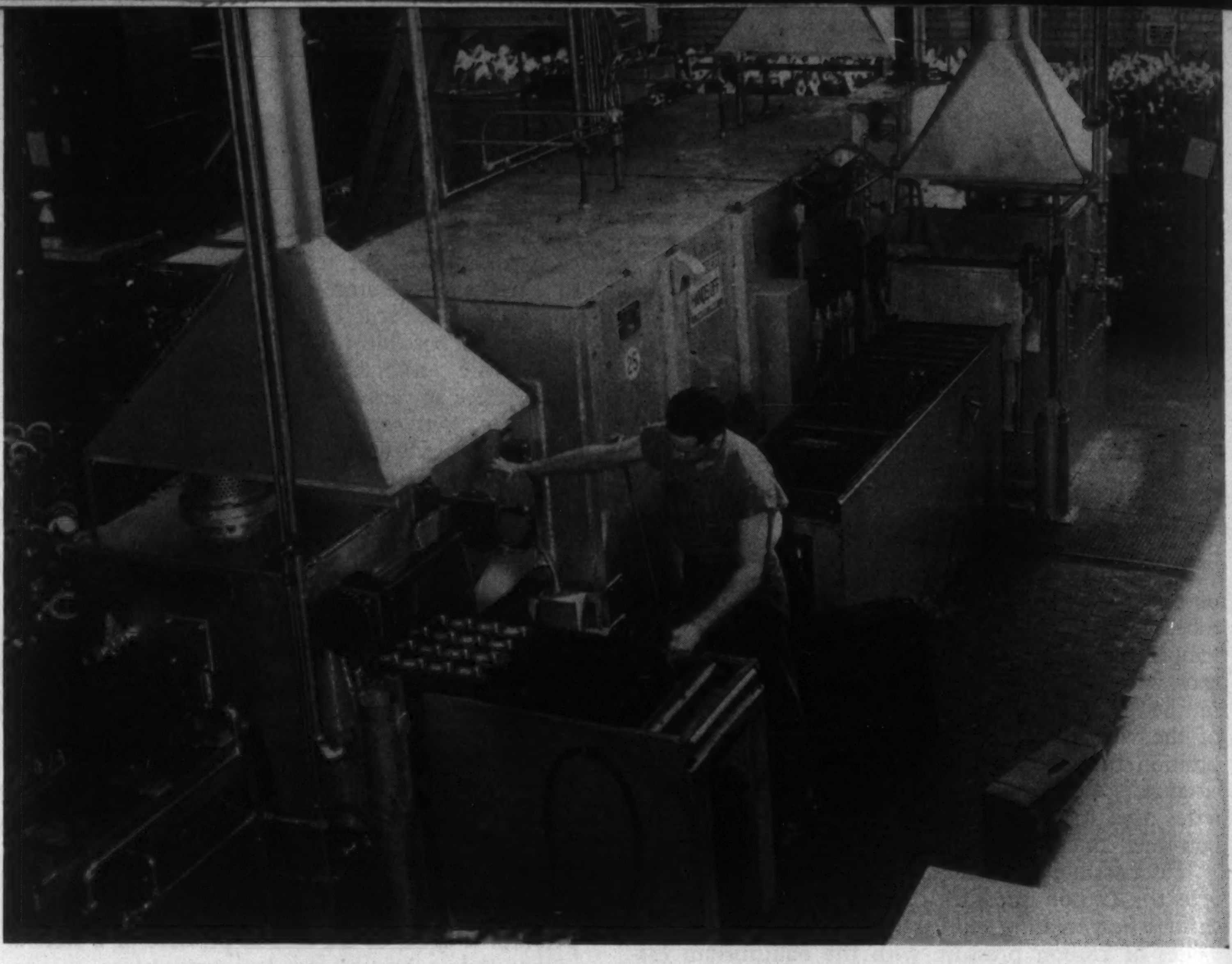


Fig. 7. A pusher type of continuous hardening furnace with built-in quench.

range of carbon pressure and still not show any particular tendencies for marked decarburization or carburization.

Also in this lower temperature range the amount of furnace impurities can be greater and still attain good results. In those cases where furnace impurities, due to door openings and other factors which allow oxygen to enter the furnace are reasonably high, it is possible to overcome the effects of these impurities by using higher carbon pressure gas. This has proven to be practical in many applications.

Also considerable experience on various applications has shown that for short cycle heat treating in a completely reacted gas like Endogas its activity is low enough to allow considerable margin of variation of carbon pressure without harmful results to the steel. An interesting example illustrates this point. Certain areas of an SAE 1020 steel part were case carburized and the part was then heated for hardening in a completely reacted gas atmosphere having a carbon pressure balanced with a medium carbon steel. After heating 1 hr. at 1550 deg. F. and water quenching the piece, it was found that the carburized areas were file hard and the uncarburized areas were soft enough to machine away. For short heating periods the medium carbon pressure will accommodate steels which have a considerable carbon range and the effects of decarburization or carburization are very small. This is a very important practical consideration since many heat-treating problems are of this type and a very large number of applications fall in the range of medium carbon contents hardened at temperatures in the neighborhood of 1450 to 1550 deg. F.

Hardening High Speed Steels

With heat treatment of high speed steels at high hardening temperatures such as 2250 and 2350 deg. F. the carbon pressures required are much higher and for these cases the equipment is operated to produce a gas having a very high carbon pressure. In some cases this requires a higher methane content in the product gas in order to give the high carbon pressure necessary. This is particularly important on tungsten high speed steels where the use of a high reducing atmosphere keeps the surfaces very clean during hardening and any decarburizing action is accelerated greatly by reason of the fact that there is no slight oxide film to protect the loss of carbon from the surface.

Tungsten high speed steels are not so sensitive to decarburization during hardening when the atmosphere is slightly oxidizing. Many so-called reducing atmospheres are in reality slightly oxidizing to tungsten high speed steels at the high hardening temperatures since at these temperatures it does not require very much carbon dioxide to make the atmosphere slightly oxidizing. For this reason the tungsten high speed steels have been successfully heat treated with very little decarburization. In so-called reducing atmospheres containing appreciable CO_2 in reality the slight oxidation has prevented the high rate of decarburization which would exist if the atmosphere were truly reducing at the high temperature. For this reason it is very important when using a highly reducing gas to have sufficient methane present in the product gas to give a very high carbon pressure.

It is interesting to note that whereas slightly oxidizing atmospheres are used to successfully harden high speed tungsten type tool steels without decarburization, the same type of atmosphere is extremely decarburizing to the molybdenum type of high speed steel. On the molybdenum types the high reducing atmospheres are more successful and actually the extremely high carbon pressures required for tungsten are not as necessary for the "moly" steels. In any case, however, when high speed steels are hardened at the high temperature ranges, the rates of decarburization or carburization are very rapid and it is important that the atmosphere surrounding the steel be virtually in chemical balance with the steel or very active decarburization or carburization will take place in relatively short periods of time.

The class of steels which harden in air as compared to a liquid quench and which contain large amounts of chromium are subject to some oxidation when hardened in a completely reacted fuel gas atmosphere. In many practical applications the amount of oxidation is not serious and the atmosphere is suitable but if the requirement is for truly bright hardening, with very small or no oxidation, then the only atmosphere which will successfully do this is dissociated ammonia, containing 75 per cent hydrogen and 25 per cent nitrogen.

Furnace Types

The conventional types of furnace equipments used for bright hardening with any modern type of atmosphere control are suitable for use with a completely reacted fuel gas atmosphere for successfully bright hardening a wide range of carbon and alloy carbon steels. The most popular of these types can be classified as (1) box type, (2) rotary hearth type, (3) pusher hardening type, (Fig. 7), and (4) belt conveyor hardening type, (Fig. 8).

The box type is adaptable for a wide range of sizes and weights of pieces which usually require individual handling and individual quenching. In this case the pieces are moved through air from the time they leave the furnace atmosphere until they are quenched, and during this period of transfer there is a slight tarnish on the work being heat treated. In a great many applications this is not objectionable and is slight enough that no further cleaning operations are required.

The rotary hearth type is also quite suitable for handling a wide variety of parts which require individual quenching and which require machine quenching. Here again the work is transferred through air for quenching and some slight tarnishing takes place.

The pusher hardening furnace is of the continuous type for high production rates of a wide variety of parts. The work is moved through the furnace on trays pushed from one position to another by means of a hydraulic cylinder tied in with automatic sequence control. In this type of equipment the quenching operation is also entirely automatic and the work is quenched in the presence of the controlled atmosphere. This equipment is of particular advantage in quality control since all of the parts are quenched automatically at the proper temperature without the human element entering into handling of the work. Also the use of an entrance purging chamber on this type of equipment makes it possible to maintain a high purity of atmosphere in the furnace itself. Another advantage of this type of equipment is that the work can be handled in quench without marking or nicking the parts.

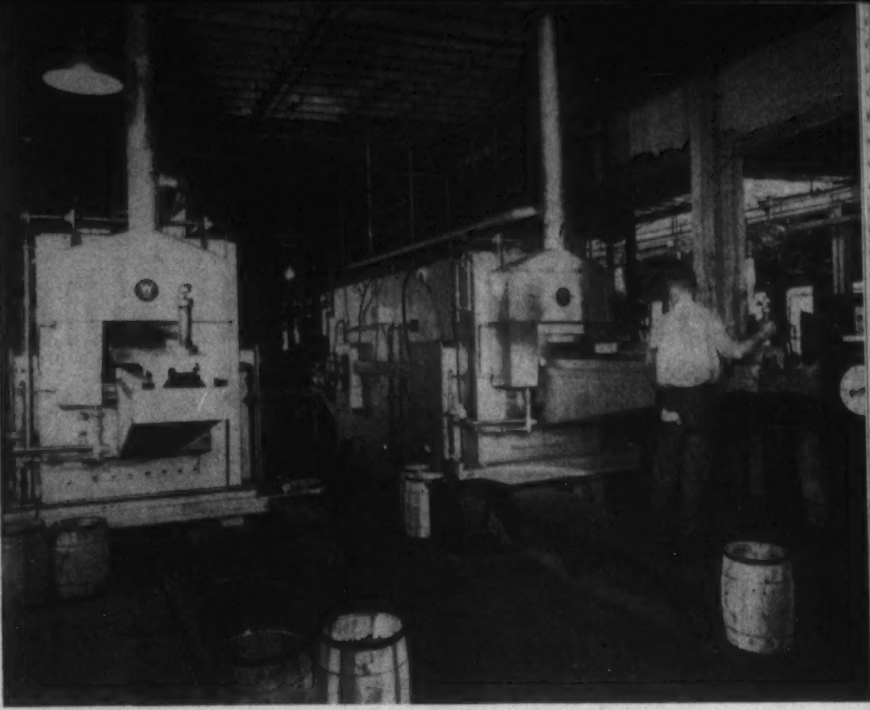


Fig. 8. A belt conveyor hardening furnace.

Where marking or nicking is not a critical problem in heat treating, the belt conveyor hardening furnace is also a very useful production tool for continuous heat treating and quenching without exposure of the work to the air during any part of the heat-treating cycle.

All of these furnaces meet certain specific individual applications. The choice of types depends on the user's individual problem and the type of work which he desires to handle in the furnace, together with the amount of production involved. The principal reason for describing these equipments is to emphasize the fact that they are all particularly suitable for use with separately prepared controlled atmospheres for bright hardening.

The developments as outlined in the use of separately prepared, completely reacted bright hardening atmospheres make possible the heat treatment of a wide range of carbon and alloy steels without decarburization, oxidation, or carburization. As a result, it is possible to heat treat finish-machined parts without further grinding, machining, cleaning or descaling operations. The use of this process has saved considerably on the man-hours and material requirements for the hardening of a wide variety of machine parts as compared to older methods where decarburization and oxidation were serious problems.

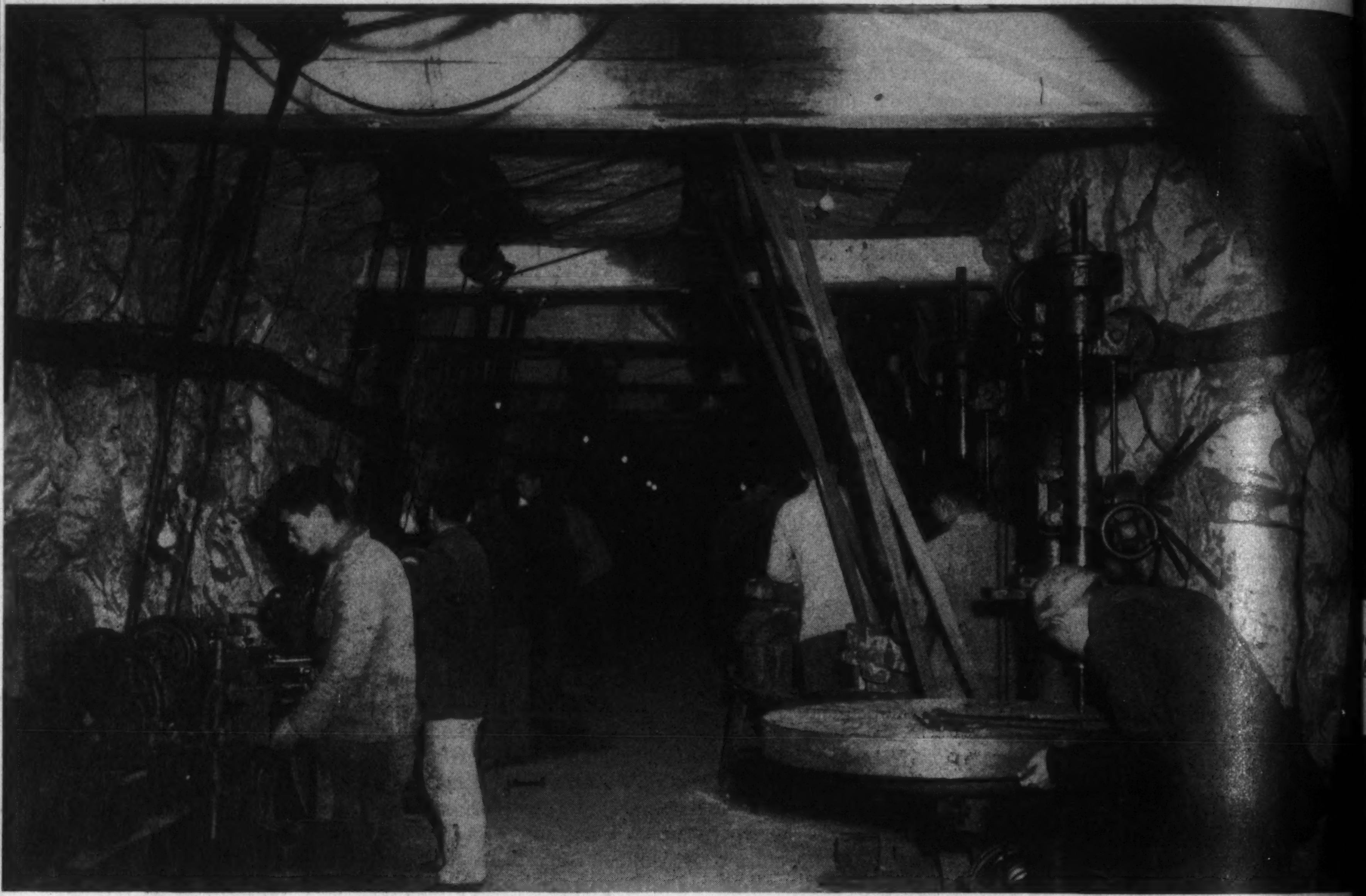
References

[1] Values of these constants for various temperatures and also as related to iron of various carbon contents are given in "Chemical Equilibrium as a Guide in the Control of Furnace Atmospheres. A Review of Equilibrium Data" by J. B. Austin and M. J. Day. From a Symposium on Controlled Atmospheres published by American Society for Metals in book form, 1942. Title of the book, "Controlled Atmospheres."

[2] For a complete discussion of balanced atmospheres and of the carbon pressure hot wire gage see "A Balanced Protective Atmosphere. Its Production and Control," by J. R. Gier, *Transactions* American Society for Metals. Sept. 1941.

China's Metal Industries at War

—A Story in Pictures



The conditions under which some of the war plants operate are unique and primitive. This is a portion of the machine shop of the Hung Shun Engineering Corp. in Chungking located in a cave far from damage by Japanese bombs.

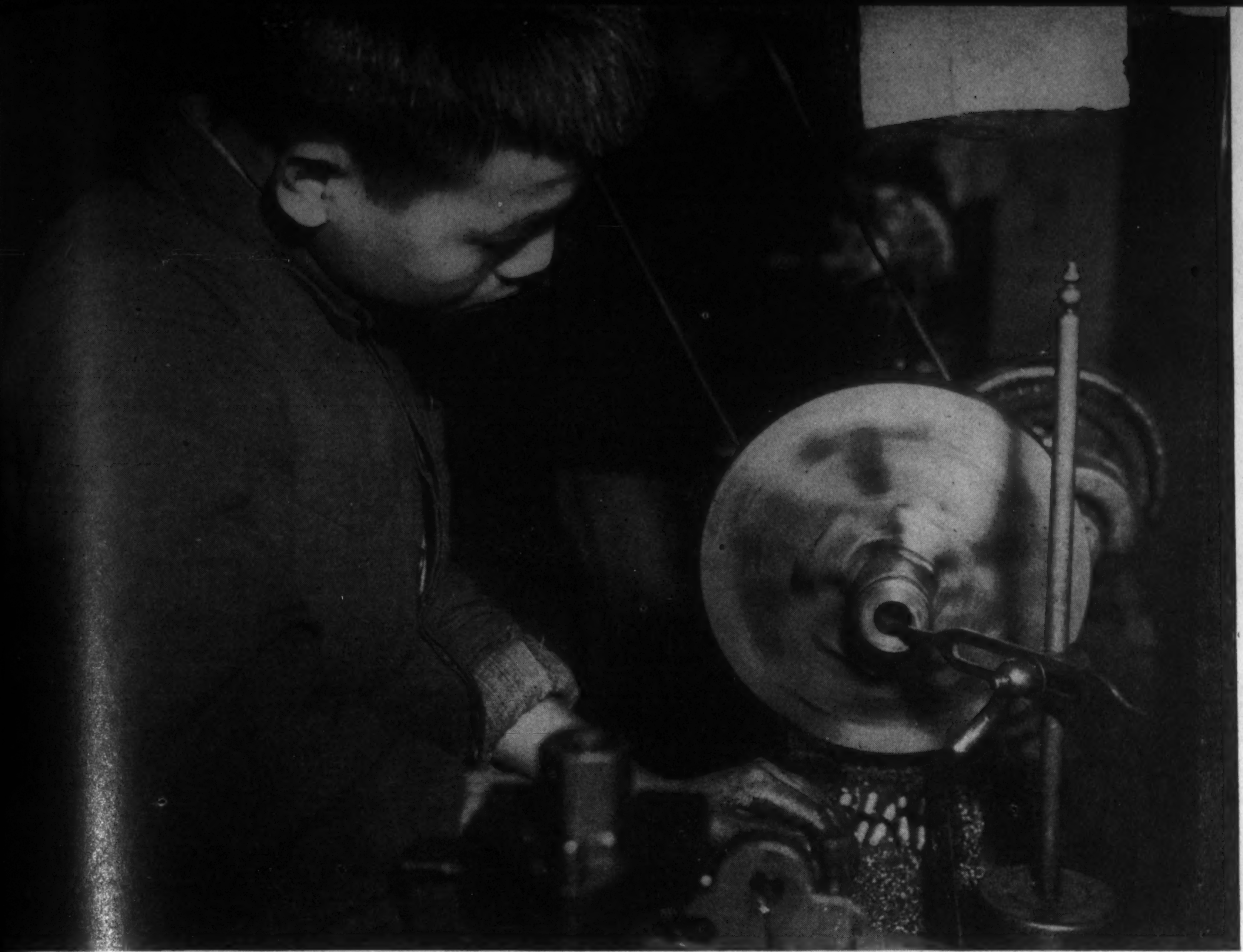
Medieval or interior China is now by no means what it was previous to the outbreak of the China-Japan war in 1937. Today it approaches a modern economic state.

Operations in iron and steel metallurgy before the war were meager. Of the 279 plants in the interior before the war, only 4 were metal-producing mills and 37 were machine works. There were of course numerous coal and iron mines, primitively operated.

One result of the hostilities has been the moving of various plants to the interior and the building of some new ones. By 1942 there were 1915 privately owned plants in the interior and 98 units of heavy industries under the direct control of the National Resources Commission of the Ministry of Economic Affairs whose heavy industry program was started only in 1936. Some of these are new plants established under the pressure of war and some are plants moved from the coastal centers—639 plants moved 117,379 tons of machinery and 12,164 skilled workmen from the evacuated areas.

There are now at least 87 privately operated metallurgical plants and 376 machine shops. In addition the National Resources Commission controls 8 iron and steel plants, 2 electrolytic copper refineries and 5 machinery works.

Some idea of the kind of operations and of the conditions under which they function is afforded by the accompanying illustrations which have been furnished by the Chinese News Service, 30 Rockefeller Plaza, New York. The captions tell the story in part.

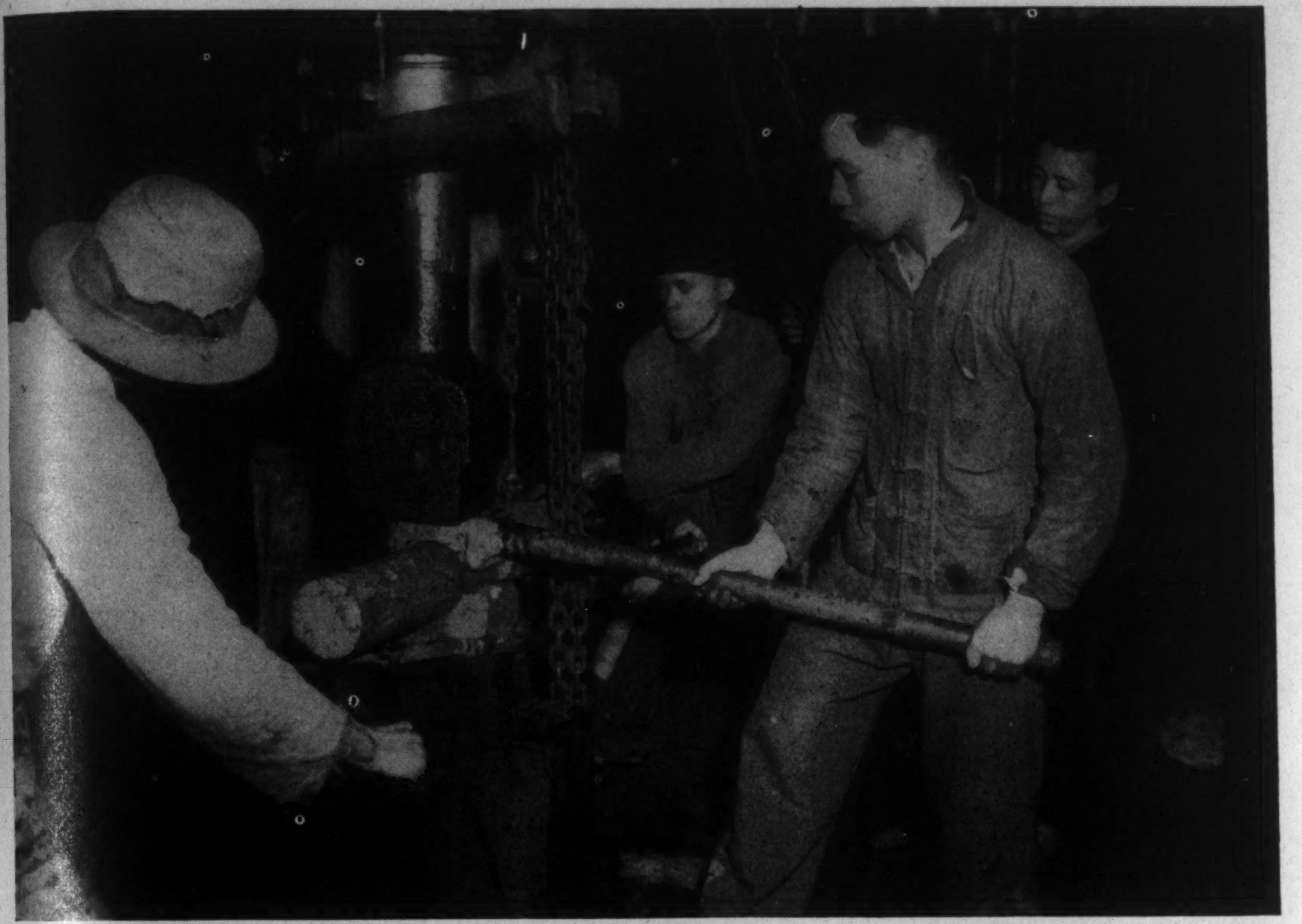


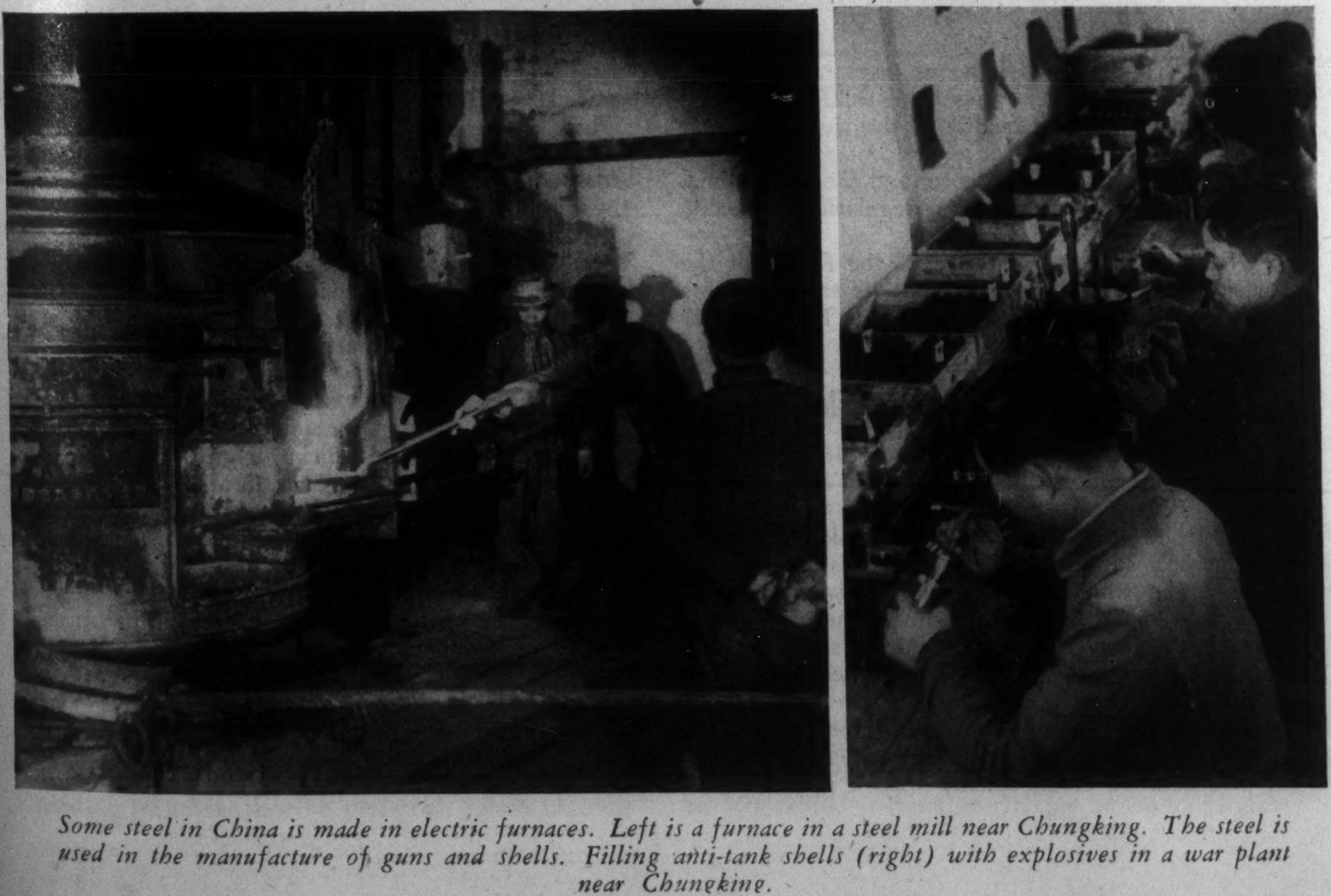
ove is a youngster, only 15 yr. old, operating one of the machine tools at the plant of the Hung Shun gineering Corp. Many types of castings are made in China. Those below are from the foundry of Hung Shun Engineering Corp. in Chungking, awaiting machining.

The Chinese produce (upper left) some of their shells. One of the early operations in their manufacture—the production of the shell cases from the discs. . . . . In some instances (upper right) construction in China today proceeds without nails. A carpenter uses his chisel to chip out a notch in the finished board. The mortise joint method is used to join boards and beams.

Pouring steel (bottom) into ingot molds in a steel mill in the interior of China.

A steam hammer operating in the forge shop of the Ming Sung Shipyards in Chungking. The men are working on the rudder bar of a ship.





Some steel in China is made in electric furnaces. Left is a furnace in a steel mill near Chungking. The steel is used in the manufacture of guns and shells. Filling anti-tank shells (right) with explosives in a war plant near Chungking.

Resistance Welding

No. 3: Supplementary Operations Before and After Welding

by **KENNETH ROSE** Metals and Alloys

The first two articles in this series on resistance welding, which appeared in our September and February issues, presented the important features of the processes and machines in use and the variations in practice for individual groups of materials. This article describes the supplementary operations — precleaning, weld-finishing, weld-testing, etc.—on which depend the production of first-class welds in all materials resistance-welded. Another article in an early issue will be devoted to resistance welding electrodes, controls and other important auxiliaries.

—The Editors

THE QUALITY OF WELDS obtained by any process is influenced by the condition of the surface of the metals being welded. This is especially true of spot or seam welding, in which the original surfaces are fused together so quickly that there is little chance for impurities to be carried away as slag. In the flash welding methods many types of surface contamination are burned away in the arc.

Remembering that the welding heat generated depends upon the current applied, time of application, and the resistance, it is obvious that if one of these factors, the resistance, varies from weld to weld the heat applied, and the quality of the weld, will vary also. Scale, rust, dirt, or other contaminant causes just this variation in resistance, and the first intimation of trouble is frequently irregularity of quality of the welds.

Not only the contamination of the faying or the outside surfaces of the work, but its smoothness as well cause variation in the resistance. The electrode pressure affects resistance also.

Cleaning Aluminum and Magnesium Alloys

A large part of our wartime spotwelding is being done with aluminum alloys. Aluminum and its alloys present special problems in resistance welding, because the result of atmospheric corrosion is a very thin, closely adherent oxide film. It is this quickly formed film which makes aluminum so difficult to solder, or to weld by most ordinary means. When consistently good welds are required, some type of cleaning of the surface will usually be necessary, especially with the heat-treated alloys.

The simplest type of cleaning for aluminum alloys is mechanical cleaning, using steel wool, a wire brush, or fine abrasive cloth, usually with a power-driven wheel. Since the equipment needed is inexpensive and methods of use require no special skill, mechanical cleaning is probably the most widely used for these alloys. Aluminum sheet, such as 2S or 3S metal, can ordinarily be used as received, unless it has been standing an unduly long time under adverse conditions. Oil or grit on the surface should be removed, however.

Chemical cleaning is more thorough than abrasive methods, but is more time-consuming, and usually requires several dip tanks of substantial size. Chemicals used for aluminum usually have an alkaline base, and a rinse dip in weak acid may be required following the alkaline treatment to rid the metal of the last traces of the caustic chemical. Several rinses in water will leave the metal clean and free of chemicals.

A hot dip in 5% caustic soda solution for half a minute, followed by a water rinse to remove most of the caustic, then an acid dip, with two water rinses would constitute a common method. The caustic solution should be held at 150 F. The acid might be dilute nitric acid, or a chromic-phosphoric or chromic-sulphuric acid combination. Trisodium phosphate may be used as the alkaline cleaner. It is a detergent also, and would remove grease or oil if present. Where a considerable amount of grease is to be removed, two alkaline baths should be used so that the work will not be contaminated upon removal from the second.

A number of proprietary cleaning compounds are marketed, most of them using some kind of alkaline material followed by an acid rinse. The alkali is frequently combined with an organic material, although soaps are not much used, due to their readiness to leave a scummy residue. Some are of a mildly acidic nature, the oxide film being dissolved by about 5 to 10 min. immersion in the hot bath, and a fresh water rinse sufficing to clean the work.

Strong acids, especially hydrofluoric acid, remove the oxide film completely, but must be used with great care to prevent damage to the work by over-immersion. Chromic-phosphoric acid is not critical as regards immersion time, but may sometimes leave a scum on the work. This can be removed by brushing during the rinse.

A paste-type cleaner that could be applied with a brush may be made with a gallon of boiling water thickened with 2.9 lb. of gum tragacanth, and including three-quarters of a gallon of denatured alcohol if the gum does not dissolve readily. The active

After the circumferential straps are seam-welded to the cylindrical portion of shatterproof stainless steel aircraft oxygen cylinders, the weld is cleaned of rough edges and scale by passing it between twin rotary brushes that simultaneously clean both sides.

ingredient is 10 lb. of 30% hydrofluoric acid, added after the gum has gone into solution. The paste should be permitted to remain on the work for half a minute, then removed with a wet cloth. Welding should be done as soon as possible after cleaning.

Magnesium alloys to be spotwelded are preferably cleaned by mechanical means—a wire brush or a polishing compound and buffing wheel. Chemical cleaning, using a chromium-pickle, can be used, but it frequently gives erratic results.

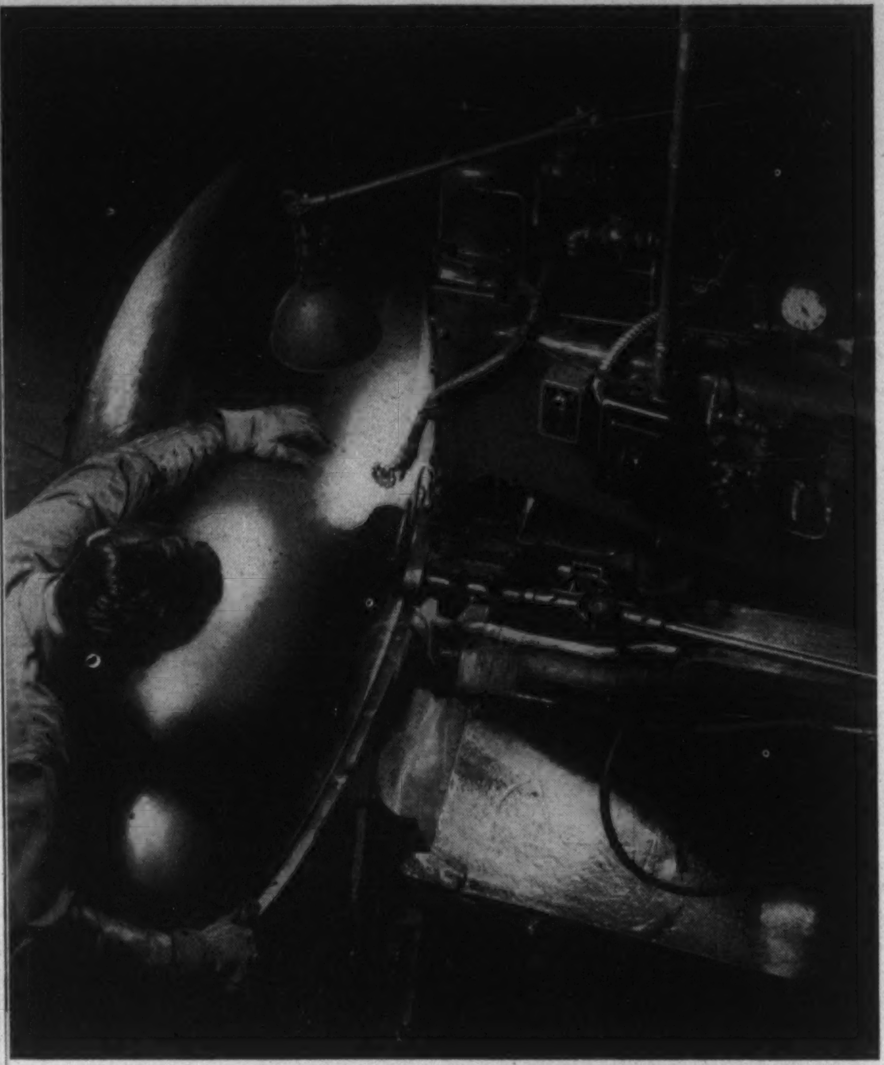
Preparation of Steel for Welding

Steel can often be spotwelded without preparation of the metal. When mill scale, rust, or slushing grease coat the surfaces, they must be removed if consistently good welds are to be obtained. Shot blasting is perhaps the simplest and cheapest means for cleaning steel, although for many small parts a pickling treatment may be preferred. Sand blasting is not recommended, as enough of the abrading material may be driven into the steel to affect the resistance.

The extent to which scale will affect the welding qualities of the work is largely a matter of the temperature at which the scale was formed. Cold rolled steel, with no scale, can be welded without cleaning unless dirt, oil, or grease cover the surface. Hot rolled steel, or heat-treated steels, may show several different types of surface scale. The tightly adhering blue-black scale is very tough, has high electrical resistance, and may make welding difficult or impossible. Lighter-colored scales will cause less difficulty, and steel with only the light straw-colored to natural scales may be welded without trouble.

Unless rust is heavy or adherent, it may usually be ignored from a resistance welding standpoint. Clean surfaces are necessary to consistently good welds, however.

Steels with a carbon content below 20 points may be spotwelded without special precautions. Higher



Droppable gasoline tanks for P-38's are made of ordinary steel, resistance (seam) welded at the rate of 60 in. per min. (4 min. for each tank). Careful precleaning is required for joints like these. (Courtesy: General Electric Co.)

carbon steels require special treatment, but this is usually a matter of special timing cycles rather than of preheating, as with arc welding.

Finishing Spotwelds

While most spotwelding requires no cleaning of the work after welding, it is sometimes desirable, for the sake of appearance, to produce invisible welds in stainless steel or aluminum. Several methods are available for concealing the indentation caused by the electrode. By using an electrode with a hollow tip for the good side of the work, a small bead is left on the metal instead of the indentation. When this bead is worked down flush and the surface polished, the location of the weld is unnoticeable from the good side. Production of welds invisible from both sides is not practical.

For flash or butt welding no preparation is ordinarily required. Where the contacting surfaces are so irregular as to localize the current sharply, a rough machining may be required as a preliminary operation to prevent local arcing and overheating. Minor irregularities are burned off in the arc, and need no special treatment. Excessive amounts of oil should be removed before welding.

Both types of butt welding leave an upset in the metal, which may be objectionable in some uses of the finished piece. In addition, flash welding leaves a small amount of spatter adhering to the work. Frequently the weld can be so placed that this upset need not be removed, but when a uniformly smooth surface is demanded a machining or grinding operation must follow the welding.

When a butt-welding machine must be used for work beyond its proper capacity, the load may be lightened by preheating the work. Another weldshop trick not so generally known as it might be is the use of a spot welder or butt welder as a riveting machine. The rivets are heated in position and pressed hot, affording a tightness of the riveted parts several times greater than is possible by any cold method. It is possible by this method to heat and press rivets too small to be heated and subsequently placed.

Testing Weld Quality

One aircraft engineer has said that the wider use of spotwelding in the aircraft industry awaits a simple, cheap, nondestructive, reliable method of testing the welds. Certainly the problem of a reliable test for resistance welding is a serious one. To date the most used tests have been "peel" tests, in which sample strips of the same material as the work are welded under the same conditions, and the welds then broken and studied. The size of the "button" pulled from the sheet is an indication of the strength of the weld. If the break occurs in the weld, insufficient current is being used, or the surfaces have not been properly prepared. Hollow buttons indicate that the work has not been properly cleaned, or that electrode pressure is too light. Improper size or shape of the electrodes will also affect the size of the buttons.

Spot welds of heat treatable material may show brittleness due to the extreme rapidity of heating and cooling, especially in thin sheets. Brittleness of welds in the strong aluminum alloys is usually caused by too high welding currents, or by insufficient pressures.

A peel test of aluminum spot welding should show a button of a diameter equal to twice the thickness of the thinner sheet plus 1/16 in. A similar test, the torsion test, involves making a single spot weld at the end of two sample strips of metal and twisting the strips apart with the weld as the axis of rotation. Some indication of the ductility of the weld metal may be obtained from the extent of twisting before the weld breaks, provided the break occurs in the weld rather than in the surrounding metal.

Both of these tests, it should be emphasized, are merely rough plant tests to show whether fusion has taken place. Their usefulness lies in their simplicity, and the ease with which they can be used to determine proper operation of the machine.

A test which can be reduced to a quantitative basis is the lap shear test, in which two strips of the material are lapped and joined by a single spot weld, the specimen being tested to destruction in a standard tensile testing apparatus. The ultimate strength of the specimen; the manner of failure, whether shearing of the weld or breaking of the strip; diameter of the button; degree of penetration, and structure of the weld are recorded.

Test specimens should be of dimensions given in the Table.

Table of Dimensions of Spot-weld Test Specimens

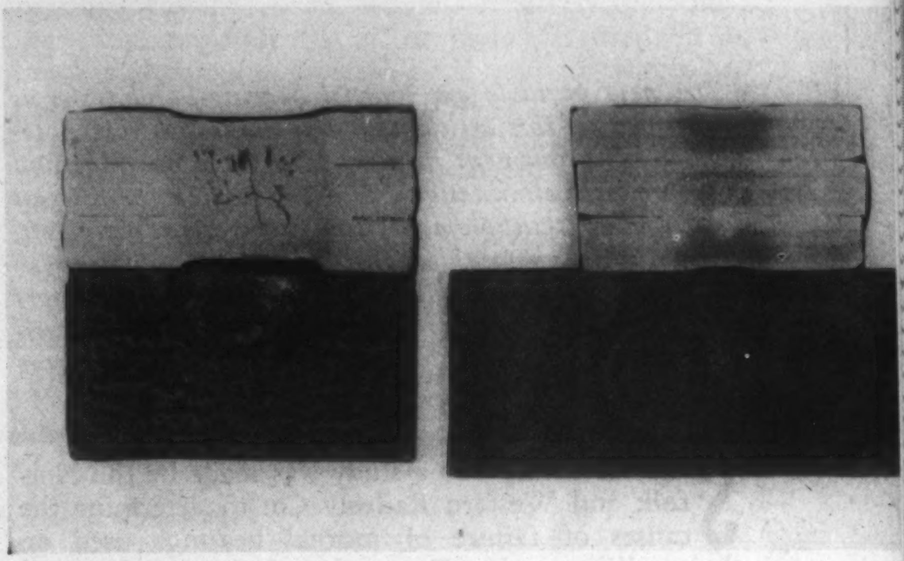
Material	Metal thickness, in.	Width, in.	Min. length each piece, in.
Ferrous metals, copper, nickel, copper - nickel alloys	to 0.030	⅝	3
	0.031 to 0.050	1	4
	0.051 to 0.100	1½	5
	above 0.100	2 (min.)	6
Aluminum and its alloys	to 0.030	⅝	3
	0.031 to 0.045	¾	4
	0.046 to 0.059	1	4
	0.060 to 0.070	1¼	5
	0.071 to 0.100	1½	5
	above 0.100	2	6

The amount of overlap should equal the width of the specimens in all cases.

In spot welding a sample strip of steel or other magnetic material, it must be remembered that machine settings for welding large sheets of the same material will not necessarily give the same values of applied currents. If the large sheets project into the throat opening of the welder, the output of the machine will be decreased due to the changed reactance of the circuit.

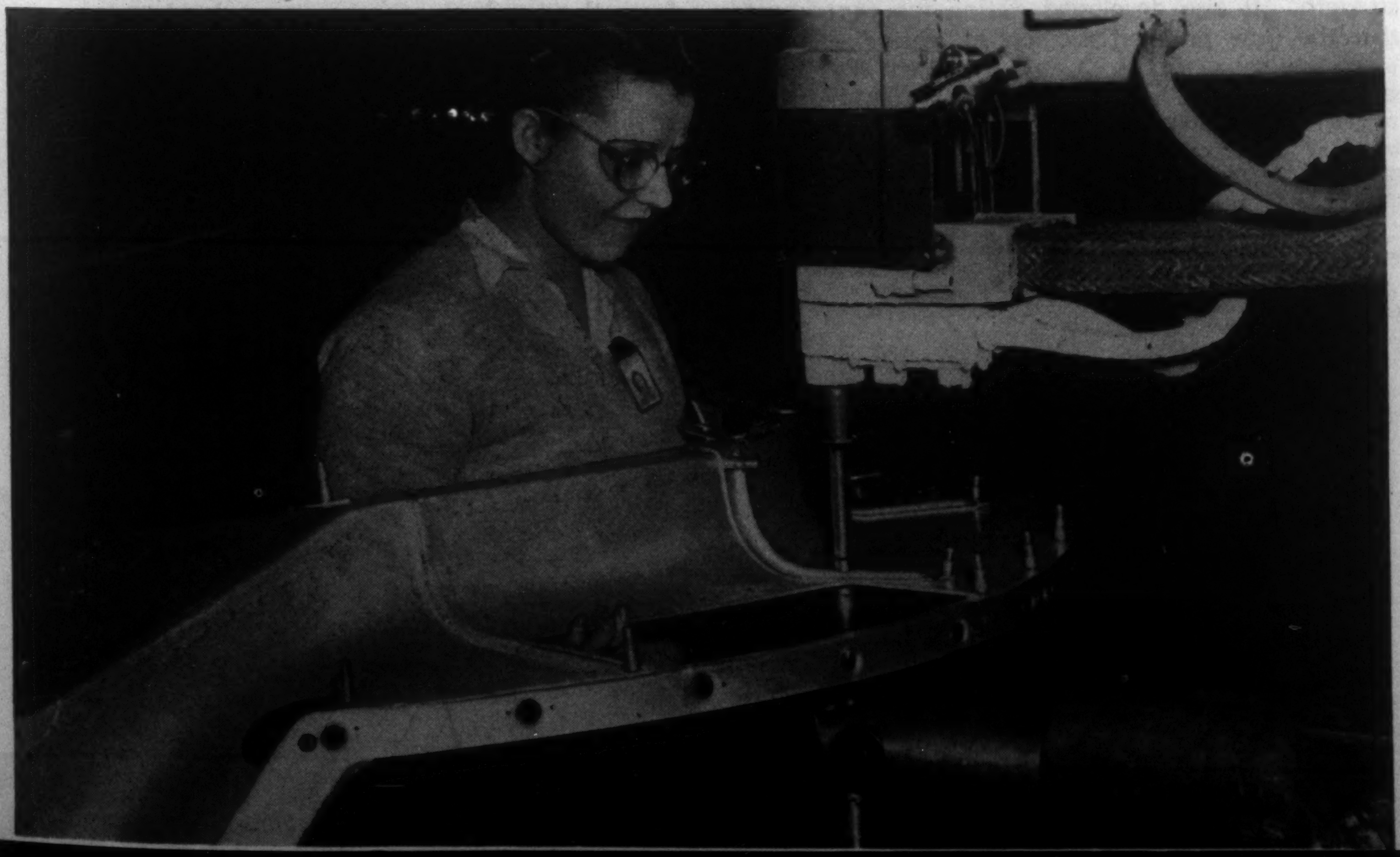
All of the preceding tests are destructive, and so are usable only on sample strips or on weldments set aside for such tests. Of the nondestructive tests, radiographic examination is probably the most used. It becomes expensive if applied to 100% of production. Measuring resistance of the weld with a Wheatstone bridge, and comparing with resistance of similar welds of known quality, is another testing method.

The effect of scale in the spotwelding of mild steel. Sections through the welds, and the outside surfaces of the metal are shown in welds of three thicknesses, the material at the left coated with scale, that at the right cleaned. Porosity, cracks in the weld, and sticking electrodes are common results in welding scaly stock. (Courtesy: General Electric Co.)



Visual inspection of the welds by an experienced inspector will give valuable information about the quality of the welds, especially if combined with peel tests on sample strips. Burn marks will indicate that the electrodes are not properly cooled, or that too much current is being used, or that welding pressure is not sufficient to prevent some arcing between the faying surfaces. Cracked welds might result from the same conditions. Spitting usually results from improperly cleaned work or insufficient pressure, and, if not seen at the time of welding will be apparent to a trained inspector in the indentation of the work, or the hollowness of the button in a peel test.

Spot welding of aluminum aircraft sub-assemblies is reported to be faster and electrode life between dressings increased through the use of a special refrigerated electrode. (Courtesy: Frostrode Products)



A Portable Bond Tester for Journal Bearings

by E. A. WOLFENDEN

Materials Inspector,
Norfolk and Western Railway Co.
Roanoke, Va.

A new portable car journal bearing-bond tester is described in this article that has made possible noteworthy improvement in railroad journal bearings and the practical elimination of bond failures for at least one road. It supplements the hammer-and-ring test, shown to be meaningless insofar as the bond strength is concerned and should be of interest to engineers responsible for bearing design and selection for various types of services. —*The Editors*

SEVERAL YEARS AGO a study was made by the Norfolk and Western Railway Co. to determine the causes of failure of journal bearings used on their rolling stock. It was found that a large percentage of failures was due to inadequate bond strength between the white metal lining and the bronze back resulting in slipped and/or cracked linings.

Experiments undertaken to improve the bond strength of the lining to the back necessitated the development of some method whereby actual strength of the bond could be measured. This was accomplished by machining from the finished bearing a test specimen which was broken in the laboratory on a universal testing machine by cantilever loading, the load being applied to the lining metal at a given distance from the bond and the strength calculated in pounds per square inch.

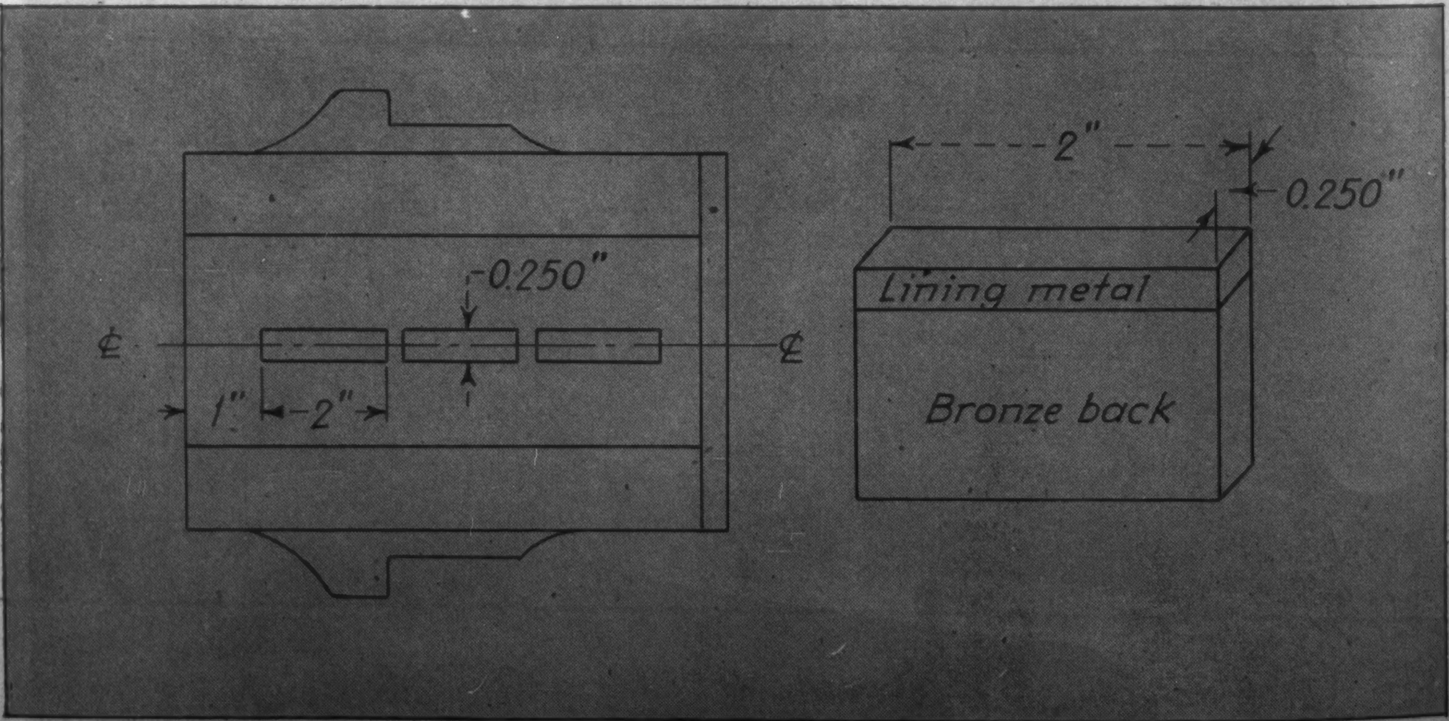
These experiments resulted in a lining procedure that increased the average bond strength of bearings relined by this railroad by 60 per cent and resulted in practically eliminating failures due to low bond strength. It also developed during the experiments that the time honored method of testing this type bearing by striking it with a hammer and noting the quality of the resulting ring gave no indication of the condition of the bond, a clear ring resulting regardless of the bond strength or as long as a bond existed entirely around the edge. Neither could an accurate concept of the bond strength be obtained by the appearance of the bond as revealed by a fractured bearing or from the chisel test.

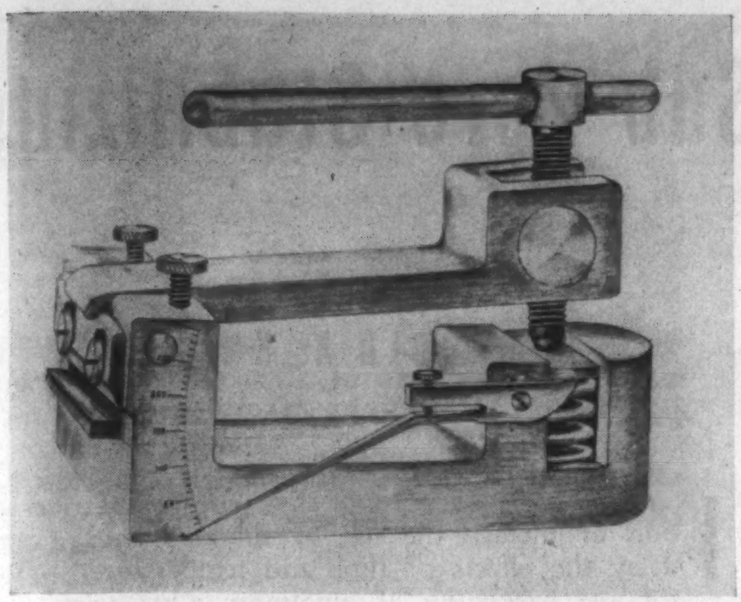
Results obtained from bond strength tests of bearings purchased from various manufacturing sources showed the advisability of placing a bond strength requirement in the specifications to which this material is purchased. However, very few plants producing railroad journal bearings are equipped with the necessary testing machine to make a bond strength determination. A portable testing machine that performs the test in the same manner as the universal testing machine was therefore devised, thus enabling the inspector to determine the bond strength of the bearings at the point of manufacture.

This portable machine has a total weight, including a carrying case, of less than 10 lbs. It derives its power from a spring which is compressed by turning a screw that acts through a rotating bearing housed in a lever arm. This lever arm has a ratio of 10 to 1 and transmits the force generated by the compressed spring onto the test sample through a blade having the same length as the sample.

The capacity of the springs used in the machine is about 300 lbs. This is sufficient force to break all except an occasional test specimen which will withstand the full capacity of the testing machine. For a ¼-in. thick specimen 2 in. long and loaded 0.10 in. from the bond, the machine can develop approximately 14,000 lbs. per sq. in. of bond strength. The

Location of the test specimen in a journal bearing.





The portable bearing bond testing machine.

average test specimen when the bearing is properly lined, will, however, generally break in the lining metal rather than at the bond thus demonstrating that the strength of the bond is greater than that of the lining metal.

This method of test has been used in the laboratory to determine the best solders and fluxes to be used in applications such as car journal bearings, locomotive bearings, crossheads, etc. where a relatively thick lining (approximately 1/8 in. or more) is used on a bronze, aluminum, or steel back, and to determine the optimum conditions to be followed in actual shop practice by taking test specimens either from the materials being lined or from prepared samples lined under shop conditions.

The advantage of this method of test lies not only in its adaptability as a low cost, portable test machine, but in the use of a test specimen easily and rapidly prepared from the bearing as produced under manufacturing conditions.

A Letter To The Editor

Cast Dies for Forging Shells

To the Editor: I was particularly interested in the performance data relating to shell piercing and nosing dies made in Meehanite metal as given by P. Attenborough in his article "Cast Dies for Forging Shells" contained in your August (1943) issue. While I agree with most of his remarks, particularly those regarding premature die failure, I cannot let his statement "of all cast materials, G.M. Meehanite seems to have performed the most successfully" pass without comment.

I think that I can safely say that my firm is one of the largest suppliers of cast shell and bomb dies in this country, and, as such, has had a wide experience with various metals used in shell piercing and nosing dies. Several years ago it was decided to adopt a nickel-chromium-molybdenum iron as the standard material for these dies. This is produced in a 30-in. diam. cupola. The analysis varies according to section and is normally within the following limits:

	Per Cent		
T.C.	2.80-3.00	S.	0.15 max.
Si.	1.60-2.20	Ni.	2.00-4.50
Mn.	0.70-1.00	Cr.	0.10-0.50
P.	0.04-0.08	Mo.	0.60-0.90

The mechanical properties obtained after a stress-relieving treatment of 5 hrs. at 600 deg. F. conform to the following range and are consistently obtained in normal production:

Tensile strength (1.2-in. dia. bar machined to 0.798 in. dia. test piece) 90,000 to 105,000 lbs. per sq. in.

Transverse strength (1.2-in. bar. 18 in. center) 4,500 to 5,500 lbs.

Incidentally, these results are comparable with those obtained in America by Flinn & Reese on a similar type of material, the main difference being that our iron has a higher total carbon through being cupola produced.

The following service results are regularly obtained with the above material: Piercing dies for the 25-pounder shell give an average of 36,400 billets, the highest and lowest figures recorded being 42,184 and 32,040. It is of interest to note that the addition of 0.15 per cent V to the above metal resulted in a considerably improved performance, the highest figure being in excess of 62,000 forgings. These results compare more than favorably with those given by Mr. Attenborough in Table I of his article.

Similar excellent results were obtained on nosing dies for all shells varying from the 75 mm. to the 9.2 in. and on A/P bombs up to and including the 500-pounder. It should be emphasized that the above results were obtained from dies which were not recut during service.

I trust that the above information will supply the confirmatory results regarding the suitability of materials other than Meehanite for shell and bomb dies.

Your readers will be interested to learn that cast iron dies are now being extensively used in the drop stamping industry. Such dies have the profile accurately cast to size so that hand finishing is all that is required on the impression. These dies are mainly being used in the stamping of light alloys, although many sets are in operation stamping steel and non-ferrous metals. Such dies have played an important part in the production of stampings for prototype aircraft, as they can be ready for operation in a fraction of the time it takes to die sink the impression in forged steel die blocks, and at the present time help to relieve congestion in the die sinking trade. Remarkable performances have been obtained, and it would appear that these cast die blocks will stand up as long as forged steel blocks.

Dies have been cast up to 2 tons in weight for each half, for use in hammers up to 5-ton capacity. The die castings are not heat treated in any way, and are manufactured in the nickel-chromium-molybdenum iron previously mentioned except that the nickel content may be increased to 5.5 per cent in very heavy die blocks. The illustrations show simple die blocks with cast impression and flash gutter, and some light alloy forgings produced from cast iron die blocks.

I should be very pleased indeed to exchange information with any of your readers who may have experimented with cast dies, or supply any further details such as method of manufacture etc., to readers who may be interested.

RONARD R. TAYLOR
Robert Taylor Co., Larbert, Stirlingshire, Scotland

Sub–Zero Stabilizing of St

The stabilization of precision gages and machine parts is a cold-treating application that is many years old but which has recently received new prominence and a sharp expansion in use. These have come about through the development of mechanical refrigerators that go down to —150 F. and which thus match the fast tempo of war production, and through new metallurgical understanding of the structural changes that occur inside the steel. This article describes the methods used by several manufacturers to "season" gages and parts via sub-zero treatment in a matter of hours instead of the months or years required by traditional "aging" practices.

Two articles on cold treatment have preceded this — one on refrigeration of aluminum alloy rivets and parts in our June, 1943, issue and one on shrink fits in our July issue. —*The Editors*

by HAROLD A. KNIGHT

METALS AND ALLOYS

IN A PREVIOUS ARTICLE in this series on refrigeration of metals, the use of sub-zero chilling to delay the effects of time and temperature — to *retard* age hardening of aluminum alloy rivets — was described. In the present article the use of extreme cold to *hasten* aging is dealt with, from which it might seem that cold treatment is a cure-all — like the bottle of whiskey on the hip of the sheriff, good to prevent sunstroke in summer, chills in winter and snakebite the year round.

The important use discussed in this article is to accelerate the aging of, "season," "set," "counter-

These are the instruments which are used to facilitate the use of gage blocks, sold in a complete package. They include vernier blocks, sine bars, straight edges, holders, scribers, caliper jaws, parallels, master flats and squares, monochromatic lights and optical flats.

teel Gages and Parts

No. 3 in a series on Refrigeration in the Metal Industries

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anneal," or "stabilize" certain steel parts where precision of dimensions is paramount, such as steel gages. Besides gages, other applications are mandrels, spindles, spindle housings, tools, dies, machine arbors and similar products, the idea being to prevent further growth in the steel part subsequent to being placed in service.

The Problem

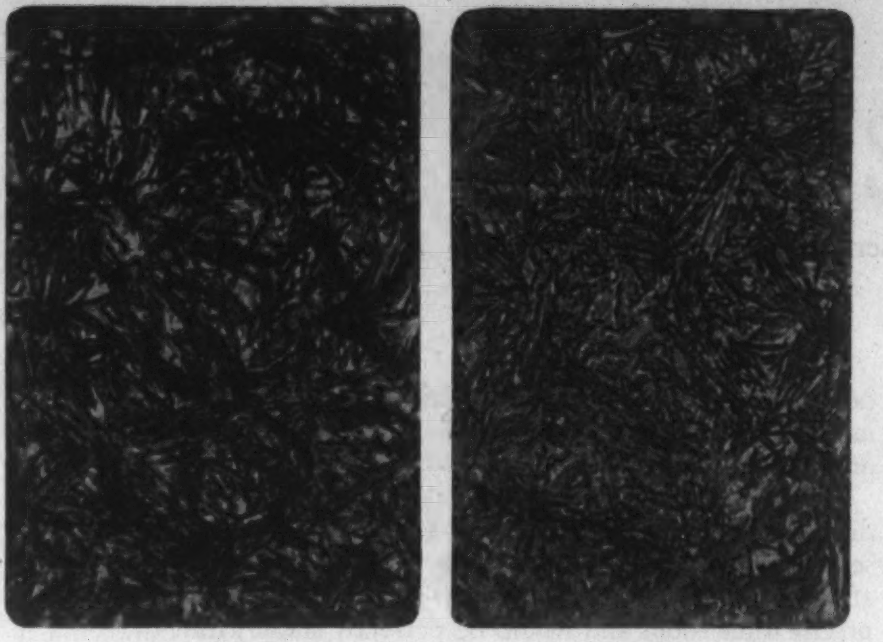
Practical men have known for decades that the dimensions of a gage block, for example, are unlikely to remain stable after its manufacture is completed but will change, through distortion and growth as much as 20 times the tolerance over a period of time. This tendency for the metal while still "green" to warp, run-out or creep was sometimes called "metallurgical ills." In the course of weeks, months or even years the metal becomes seasoned or stabilized by itself.

For this reason, heat-treated gage blocks were traditionally stabilized by leaving them outdoors for several years until all warping had spent itself, after which they could be finish-machined to final, precise dimensions and would be perfectly stable from that time on. Other methods used in bygone years to speed aging bordered on the superstitious, among which were the hanging of a piece of metal by a rope and banging it with a hammer.

More recently the practice has been to rough-machine and harden the block, then allow it to age for 1 to 3 yrs., and finally hold for a matter of hours at —50 F. before finish-machining. Modern gage manufacturers, however, have tremendously speeded

Here are the finished blocks and instruments packed away in their case and ready for use with an accuracy of plus or minus 4 millionths of an inch. ▸▸

DoAll Gages
SERIAL 859
GRADE A
DATE 6-8-43
ACCURACY .000004
SAVAGE TOOL CO.
SAVAGE, MINN.
KEEP CASE CLEAN
WEAR BLOCK
DoAll Gages 2.000
DoAll Gages 1.000



At the left is the grain structure of the SAE 52100 steel when given a normal draw; at the right, the same after sub-zero treatment in addition. Note the considerable amount of untransformed austenite in the former.

up the necessary stabilizing process by applying the most recent research findings on steel transformations, together with chilling temperatures as low as —120 F.

The trouble with the gages in the first place is that the change in structure from high-temperature austenite to martensite that quenching is supposed to produce is not completely accomplished when the quenching temperature (*i.e.* the temperature of the quench medium) is the usual +60 to 200 F., and residual untransformed austenite remains. The suppressed desire of the steel to complete that change then proceeds to find release very slowly over a period of years at normal temperatures and in doing so warps the gage out of size. However, as Morris Cohen and his associates at Massachusetts Institute of Technology have recently demonstrated, this change will be completed at the beginning if the steel immediately after quenching is brought down to —100 to —150 F. for a suitable time.

Commercial processes have therefore now been developed whereby steel gages, gage blocks, mandrels, spindles, etc. are completely "seasoned" or "stabilized" in about 48 hr. by hardening and quenching in the usual way, chilling to —120 F., tempering at a selected temperature above 300 F., and then repeating this cycle a few times. Satisfactory stabilization for most purposes is also claimed for similar cycles using chilling temperatures in the neighborhood of —50 F. As one exponent of the method expressed it — in a case where a gage received two chills and one heating, it was equivalent to weathering through two winters and one summer.

Stabilization by extreme chills and moderate heats alternately is good, logical metallurgy, too, we were told by G. V. Luerssen, metallurgist, Carpenter Steel Co., Reading, Pa. As he puts it, the net result is a combination of the break-down of the austenite in the original quenched steel by the low temperature treatment, followed by the relieving of stress in the resulting martensite by heating slightly in oil. Repetitions of this cycle ultimately result in complete stabilization, which simply means a structure which has no tendency toward further break-down.

The problem is recognized as important from the precision as well as the fast-production point of view. One man far advanced in the technique of this procedure, John A. Harrington, president, Savage Tool Co., Minneapolis, calls attention to the fact that the National Bureau of Standards recently set up a test of stability to which all sets of gage blocks are subjected. This test consists of boiling the block in a 1/2 to 1% solution of potassium dichromate and water for 24 hr. Should the block change in dimension by more than two millionths of an inch it is not considered stable.

Mr. Harrington adds that it does little good for the tool maker to finish and accurately inspect a master gage to within, say 10 millionths, and then, when it is taken from the shelf in the inspection department, find that it has grown or shrunk perhaps 200 millionths. It is particularly fatal in the case of a master gage.

Methods of Procedure

Methods of cold treating gage steel are far from standardized. P. C. Farren, chief metallurgist, Greenfield Tap & Die Corp., Greenfield, Mass., states that he has been unable to find, in conversation and correspondence with numerous manufacturers throughout the United States, any agreement within reason as to stabilization treatment of gage steels. Many companies have adopted treatments with little or no data to back up adoption of any particular procedure.

The only statement that he would care to make with any degree of certainty at present is that effective stabilization treatment is tied in with the type of alloy steel used and the previous history of the steel; that is, mill practice, rolling, forging, heat treatment, etc. It seems that no stabilization treatment may be applied indiscriminately to all gage steels without taking into account their composition and previous history.

Mr. Harrington of Savage Tool Co. found that by repeated cycles of bringing the blocks (made of SAE 52100 steel) from quenching temperature to —120 F., then up to room temperature, all growth was arrested but that the retained austenite which had been transformed into martensite necessitated the tempering of the martensite to prevent shrinkage. So, by cycling the part from the quench to —120 F. and back through room temperature, then up to tempering temperature, then back through room temperature down to —120 F., the part could be completely stabilized after approximately 6 cycles, if the treatment always ended with the tempering operation.

This rapid method, taking about 48 hr., was described as a very great improvement over the methods used originally. During the earlier days of the refrigeration era these blocks were machined up to the finishing operations and then allowed to age from 1 to 3 yr., after which they were "frozen" at —50 F. and then finished. This, however, was too slow for wartime.

Mr. Harrington does not believe that sub-zero treatment has yet reached the point where one can predict with absolute accuracy the length of time or number of treatments for each class of steel. However, the method described above for SAE 52100 steel has met wide approval and is in general use by most manufacturers of precision parts.

Some general rules must be followed, according to this authority: (1) Temperatures must be below —100 F. (2) Treatment must be a continuous operation and must not be allowed to rest at room temperature. (3) One treatment is not enough. (4) The degree of stabilization depends on the number of cycles of heating and freezing.

Others' Practices

Most of those manufacturers whom we consulted in preparing this article have been conversant with this subject for only a few years—some for only months. Unusual, therefore, is the experience of A. Gabriel, vice president in charge of production, Acme Industrial Co., Chicago, which makes standardized jig and fixture bushings and hardened and ground parts to order. For many years Mr. Gabriel has been working out chilling and heating processes to promote seasoning and improve wearing qualities.

He states that at the present time all their products requiring stability are chilled in a refrigerator in which a temperature of —60 F. is maintained. The number of treatment cycles varies from 1 to 6, depending on the shape, structure and end use. Thus plug, ring and thread gages are given a 4-cycle treatment over a period of a week to 10 days.

Hardened and ground precision items when assembled into castings or cold-rolled steel plates receive one cycle and an additional cycle after they have been pressed in their places. This extra cycle is to take care of possible later shrinkage due to stress relieving between component parts possessing different coefficient of expansion factors. This additional cycle is a safeguarding measure to keep equipment operating under varied temperature conditions encountered by our boys in the fighting areas. (More from Mr. Gabriel later.)

C. L. Olin, Servel, Inc., Evansville, Ind., a concern which manufactures refrigerating equipment, describes briefly two methods of chilling various gages, including blocks, go and no-go limit gages, plug gages, etc.:

In the first method they are first shaped, hardened and ground to within about 0.002 in. of the final dimensions and then placed in a low temperature cabinet and held at about —50 F. for 10 hr. Removed, they are allowed to reach room temperature normally and then placed in oil. The oil is increased gradually to 200 F., the batch soaking for 4 hr. The parts are removed from the oil and again allowed to reach room temperature. They are again brought down to —50 F., kept there for 10 hr., then brought back to room temperature.

A second process involves filling the low temperature cabinet with a suitable non-freezing solution and chilling to —55 F. The gages or parts are formed, hardened and ground to within 0.002 in. limit and immersed in the liquid. After remaining for 8 hr. they are removed and brought back to room temperature. The parts are then finish ground and lapped. The exponents of this method state that stresses will either be relieved or will show up as checks when taken from the liquid.

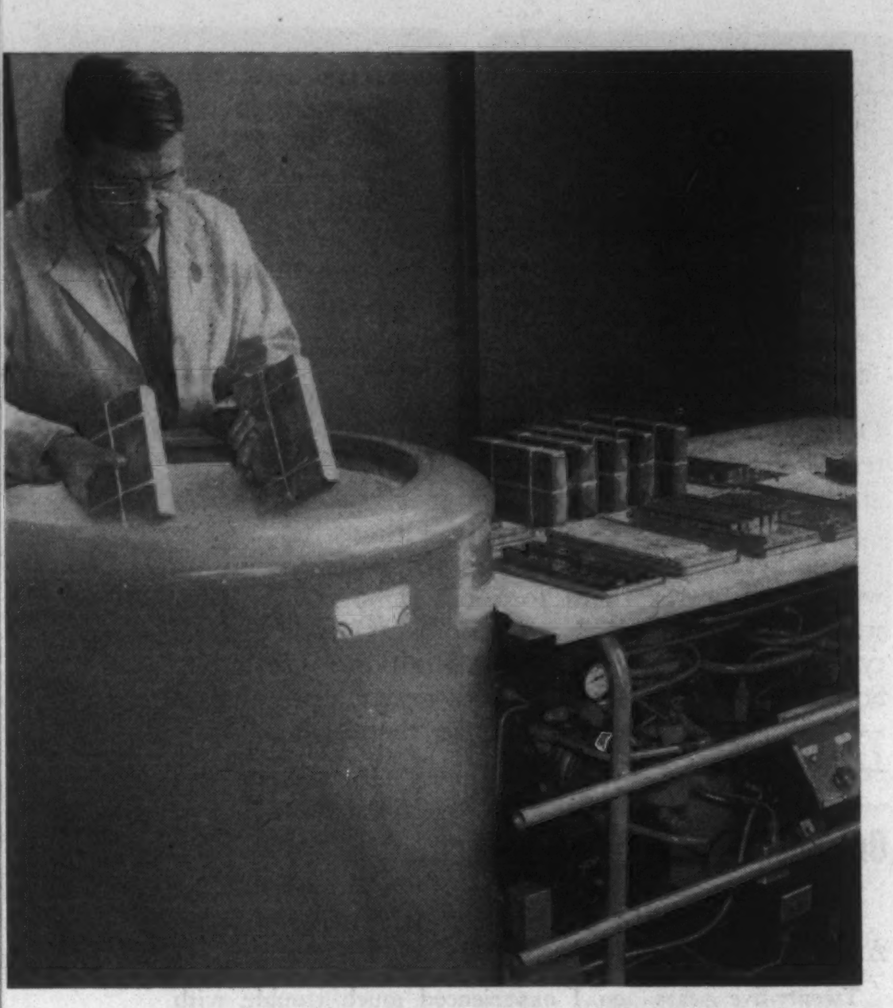
Several processors use much lower temperatures. One has found that reducing the counter-annealing temperature to —100 F. or lower fully relieves the strain, so that once the gage is resized after this freezing, it retains its precise size thereafter.

Another manufacturer places the parts in boiling water and brings them to room temperature, after which they are chilled at —50 F. overnight. The cycle is repeated if further stabilization is desirable. Still another prefers to keep the temperature around —50 F. and to leave the gage there for at least 12 hr.

One Company's Early Experience

Now to get back to the historical experience of A. Gabriel of Acme Industrial Co. He states:

> Twenty-five years ago I experienced much trouble with motor rotors seizing in the motor bearings — and despite 100% maintenance. We noted that European machines had the reputation — and lived up to the reputation for metal stability. We concluded that in our case a rearrangement of the crystalline structure was taking place.
>
> We then began to chill such materials as we thought might cause trouble by changing size, and to our surprise, found that parts made in the conventional way, then chilled after heat treatment, were outlasting the unchilled parts. We conducted experiments — not in the broad sense of research, but merely to make our products superior to those of competitors.
>
> We had a two-fold aim: (1) To bring about stability in our products after manufacture and (2) to incorporate better wearing qualities than goods of rivals. We decided that springs would be a good guinea pig for our studies. We constructed two kinds, one of a single metal and the other of bi-metal. With ordinary treatment, it took tens of thousands of deflections before the relaxed springs returned to an invariable position — in other words, before they attained stability by work hardening. The stability was obtained much sooner when springs were chilled to —10 F., then given a draw to +325 F. following the chilling, repeating these operations over 4 cycles.
>
> In 1933 we received orders from a large greasing equipment manufacturer for piston and cylinder assemblies whose pressure creating requirements ran into thousands of pounds per square inch and by sole virtue of their fit — no packing. These parts in their assemblies are subject to great temperature variation, according to locality. By that time dry ice had appeared. We built a chamber, with insulation 1 ft. thick, in which the parts were chilled at —109 F., redrawn to +325 F. Stability was achieved after only 4 cycles of this alternate treatment, plus in-between operations, such as rough grinding, finish grinding, rough lapping and finish lapping.
>
> Then came photomicrography and better methods of polishing samples to show grain structure before and after treatment, which helped us in our studies. In the ac-



Here instruments, shown in another illustration, are being placed into the sub-zero cabinet for chilling. Before it is given the final chilling operation each flat is carefully greased and wrapped in paper, to eliminate the possibility of deep scratches.

companying illustrations are two photomicrographs of SAE 52100 steel, heat treated and drawn in the conventional manner in one instance; the same plus frozen in dry ice for 3 hr. in another. The left hand section shows the structure as obtained from a normal draw as given SAE 52100 steel; the right, when frozen in addition. The left hand picture shows definitely austenitic structure; the right has undergone transformation and definitely shows a martensitic structure. (Experiments by Roy Roshong of Harvey S. Pardee & Associates.)

Besides hastening stabilization, it is apparent that wear-resisting qualities are improved by chilling. Some of our draw punches, furnished to large users, were merely heat treated and drawn; others were heat treated, drawn and chilled through 4 cycles. After we had delivered these products, we made frequent inquiries as to performances and lasting qualities. We concluded that the chilled punches gave 15% better wear performance.

Development and Research

A scientific approach to the subject is being conducted by metallurgists of the Greenfield Tap & Die Corp. in conjunction with Dr. Morris Cohen, Department of Metallurgy, Massachusetts Institute of Technology. Variables which crept into previous investigations are believed due to measurement irregularities. Hence investigators concluded that some form of test pieces, other than thread gages or plain plug gages must be adopted.

Dr. Cohen believes that, in order to measure the very small dimensional changes which occur, fairly long test pieces of small diameter must be adopted. Such pieces involve some rather careful technique in spherical grinding of both ends of the bar and finishing the over-all length of all bars within close limits at the same time. Bars of various gage steels would be prepared and these would be subjected to various stabilization procedures. As this is being written, progress has not been advanced enough to warrant inclusion of results in this article.

In addition to its function of hastening the austenite transformation and obviating the usual long aging treatments for gages, sub-zero quenching is evidently able to produce in high speed tool steel combinations of hardness, strength and ductility unobtainable by ordinary methods. More information on this is also among Dr. Cohen's aims.

Refrigeration Equipment

Although we should like to present it, space considerations will not permit a lengthy discussion of the engineering features of refrigeration equipment used for seasoning gages (as well as for the operations described in the two preceding articles). Some of the common means for commercially chilling metal parts, and the sub-zero temperatures they produce are as follows:

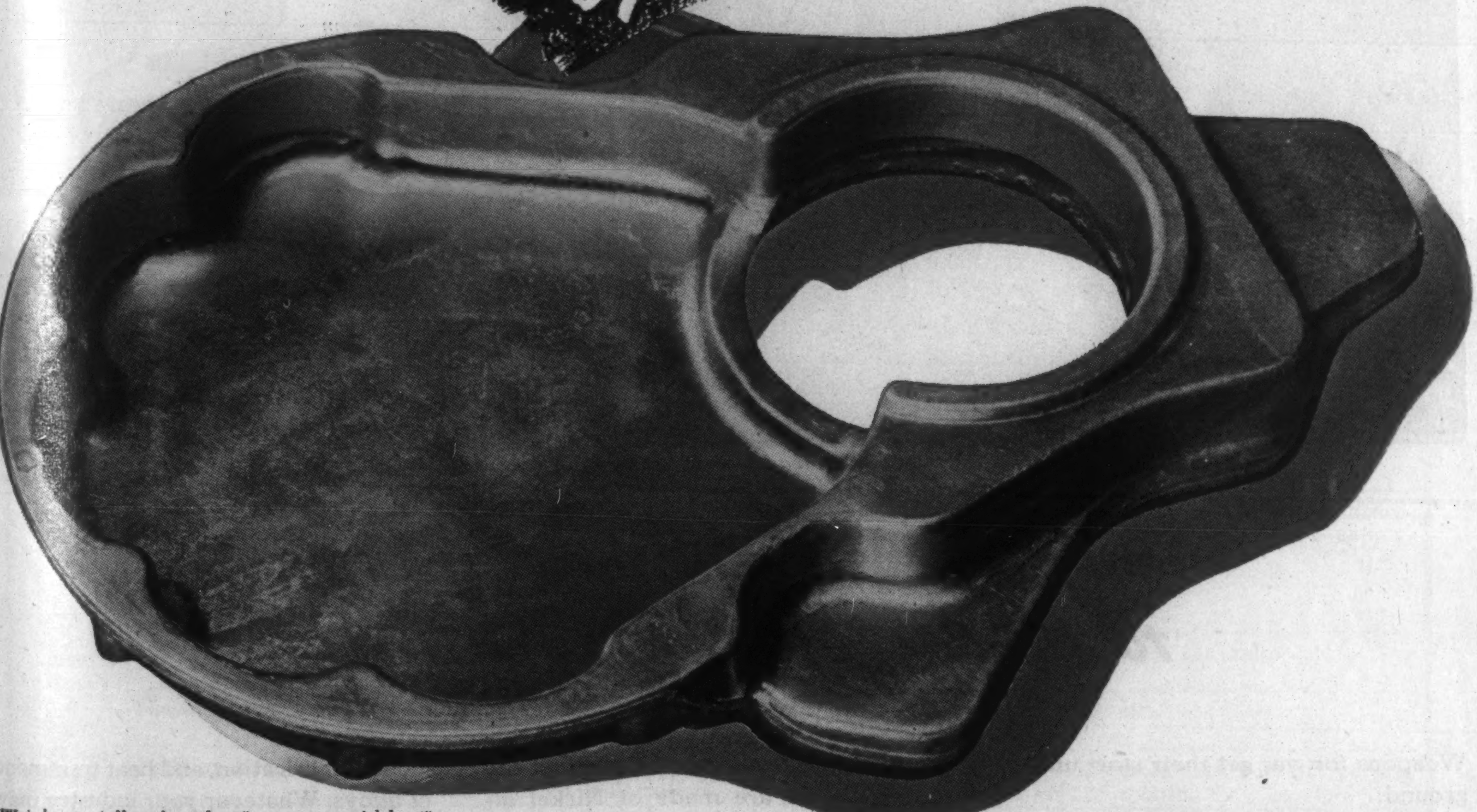
Cooling Method or Mixture	Approx. Lowest Temp., Deg. F.
Salt and cracked ice	—6
Mechanical refrigeration (single stage)	—50
Mixture of dry ice and alcohol	—98
Dry ice alone	—108
Mechanical refrigeration (2-stage)	—150
Liquid air	—314
Liquid nitrogen	—410

The three largest manufacturers of mechanical chilling equipment designed for a wide variety of metal-working applications are Deepfreeze Division, Motor Products Corp., North Chicago, Ill.; Kold-Hold Mfg. Co., Lansing, Mich.; and Revco, Inc., Adrian, Mich. With the exception of two or three special models that use propane as the refrigerant, all the units made by these companies employ simple mechanical refrigeration systems, either single-stage or two-stage, using Freon 12 or Freon 22 as the refrigerant that is compressed and then allowed to expand and thus absorb heat from the chamber or parts to be cooled.

Most of the Kold-Hold and Revco units are mobile whereas most of the Deepfreeze machines are high-heat-removing-capacity, stationary units; certain Deepfreeze models provide the lowest temperatures of all — down to —150 deg. F. Other metal-refrigerating unit manufacturers are Brunner Mfg. Co., Utica, N. Y., Sweden Freezer Mfg. Co., Seattle, Wash and General Electric Co., Schenectady, N. Y.

AN INTRICATE DIE-PRESSED ALUMINUM FORGING

by REVERE



Weight: 1¾ lbs.; length: 9″; extreme width: 6″

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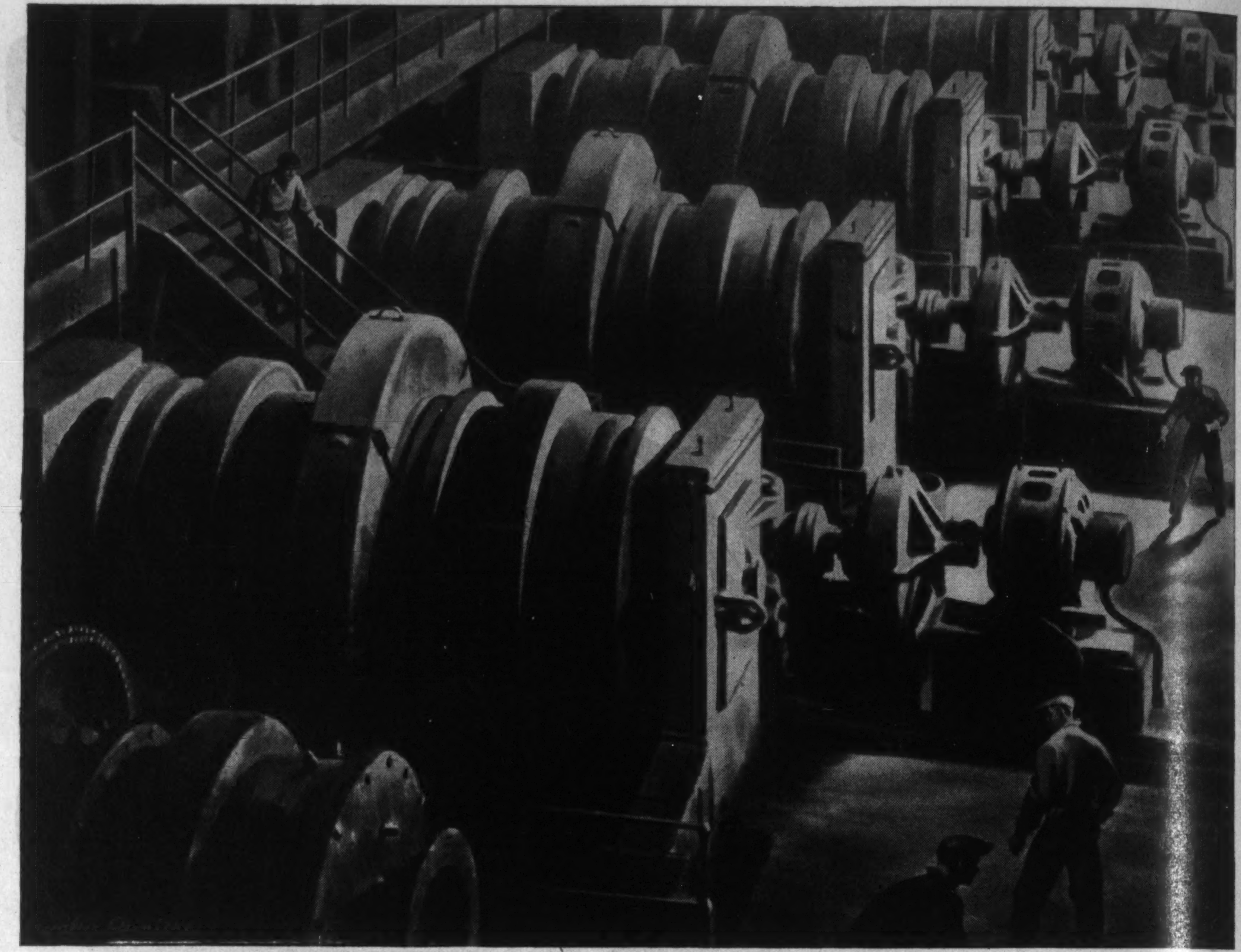

Grinding mills used to reduce ore to appropriate size for treatment

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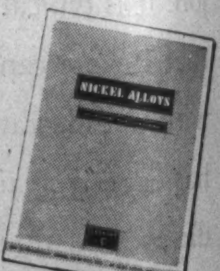

★ Nickel ★

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall St., New York 5, N.Y.

METALS and ALLOYS

Engineering File Facts

NUMBER 40
March, 1944

PROCESSES AND PROCEDURES
Machining

Machine Tools and Machining Operations

Machine tools, while of only a few basic types, are extremely difficult to classify because the machines are too versatile to be sharply divided by functions, and have taken too many specialized forms to be rigidly grouped upon that basis. Thus, a deep hole driller resembles a lathe in form, and a drillpress in function; a triplex machine combines the functions of a lathe, drillpress and milling machine, without resembling any one of them very closely. The machines have been classified as single-point or multiple-point tools, or according to certain basic types. While neither classification is entirely satisfactory, the latter is used here, as the more familiar.

The purposes of machining are the removal of material, the improvement of dimensional accuracy and the refinement of surface finish, and a given piece of work may be machined with any or all of these objectives in view. A surface may be *formed,* with the finished surface a replica of the shape of the cutting tool, or *generated,* with the shape of the finished surface determined by the relative motions of tool and work, and practically independent of the shape of the tool. Thus, we have formed cutting tools on one hand, or a gear generator on the other. Generated surfaces are usually plane, cylindrical, conical, helicoidal or involute, while formed surfaces may be of almost any shape. The former are usually easier to produce, and may be finished to closer tolerances.

General Type	Specialized Types	Form	Uses
Drilling Machine—primarily a machine to originate holes in metal	Portable drills	Small, integral — motor hand tool.	Basically the simplest of the standard machines, applications of the newer types are greatly broadened. May be used for drilling, reaming, tapping, counter-sinking, counterboring, keyseating, spot-facing, lapping, etc.
	Bench drillpress	Small machine for light or precision work.	
	Upright drillpress	Standard type.	
	Radial	Arm can be revolved about column.	
	Multiple - spindle drilling machine	Two or more spindles driven independently or otherwise.	For high production work, as cylinder heads, pipe flanges, etc.
	Horizontal drilling press	May be multiple-spindle — usually fitted with special straight-fluted drills.	For drilling long pieces that could not be conveniently placed in vertical position.
Shaper—primarily for generating flat surfaces	Horizontal shaper	Tool held in reciprocating ram — work fed through line of motion of tool.	May be used when a short cutting stroke is needed. Usually a toolroom or job shop machine. For horizontal or vertical flat surfaces, keyseating, notching, and (slotter) gear cutting, and splining.
	Vertical shaper or slotter		
Planer—primarily for generating large flat surfaces	Several types not sharply defined. May have several tool heads, on cross rail or side housings.	Work carried on reciprocating bedtool fed horizontally or vertically across line of motion of work.	Usually used for larger, heavier work than shaper. For horizontal, vertical, or angular surfaces; keyway cutting, T-slot cutting, dove-tailing, splining shafts, planing convex surfaces with centers.
Lathe—primarily for machining surfaces in revolution — the most versatile of all the machine tools	Bench lathe	Small — mounted on bench.	For turning, boring, tapering, drilling, thread-chasing, facing, knurling, polishing, tapping, reaming.
	Engine lathe	The basic type — work mounted between centers, or held in a chuck, to rotate about a horizontal axis, with tool moving longitudinally or transversely in a horizontal plane.	
	Gap lathe	Ways notched or discontinuous to permit swinging large-diameter work.	For turning large pulleys, car axles, etc.
	Shafting lathe	Very long ways, with one or more steady-rests.	For turning, shafting, etc.
	Profiling lathe	One or more saddles with guiding templates to give the required tool motion.	For generating surfaces not parallel or perpendicular to the axis of rotation.
	Turret lathe	The saddle mounts turret holding tools, which can be brought successively into working position.	For production turning, boring, drilling, etc., on work held in a chuck.
	Vertical turret lathe	Axis of rotation of the work is vertical, and tools are positioned above work.	For work that can be better held or more rapidly set up on a horizontal table.
	Automatic threading machine	Work fed automatically to chucked dies, and automatically released when thread is cut.	For mass production of machine screws.
	Automatic screw machine	A cam-operated bar stock turret lathe, in which the stock is automatically fed, cut off, rotated to successive stations and machined, and discharged from the machine.	Mass production of intricately machined small parts. Turning, facing, forming, drilling, tapping, etc., may be done in succession at the machine stations.
Boring Machine	Vertical boring mill	Work is clamped to horizontal revolving table — tool moves vertically.	For boring, facing, etc., pulleys or other large work.
	Jig borer	Work is fastened to a saddle, providing for precision vertical or horizontal positioning. Rotating cutting tool moves vertically.	A high-precision machine for tool making, die sinking, etc. Boring, milling or drilling may be done very accurately.
	Horizontal boring machine	Work fastened to saddle, tool revolves on horizontal axis.	For accurate milling, drilling, boring, slotting, tapping or reaming when the work cannot be conveniently revolved.

(Continued on page 619)

NIGHT LIFE 1944

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Engineering File Facts

NUMBER 40 (Continued) **MACHINING**

General Type	Specialized Types	Form	Uses
Milling Machine—versatile machine, of many specialized types	Bench miller	Work usually fed past rotary multiple-toothed cutter or cutters.	Much work formerly assigned to shapers, planers, or lathes is now done on milling machines. High production machines of widely varying types. For slitting, slotting, drilling, generating plane or curved surfaces, cutting gears, threads, etc. Profile- or form-type cutters add to versatility.
	Horizontal miller		
	Vertical or end miller		
	Planer-type miller		For heaviest work — usually multiple cutters.
	Rotary-type miller	Work mounted on table rotating in horizontal plane.	For high production. Work unloaded at last station and replaced during continuous operation.
	Drum-type miller	Work held on drum rotating about horizontal axis.	
	Planetary milling machine	Work clamped to table, cutter rotates.	For plain or formed internal or external surfaces.
	Profiling machine	Work clamped to vertical table, cutter or cutters duplicate pattern from a template.	Reproduction of intricate or irregular surfaces.
	Thread miller	Formed cutter cuts thread as work revolves.	For milling threads, teeth on worms, etc.
	Gear hobber	Cutter forms gear teeth as work is fed past it.	For milling spur gears, worms, worm wheels, etc.
Broaching Machine—primarily for forming non-round holes	Push broaching machine	Broach forced through lead hole or against work surface by press.	For finishing holes of circular or non-circular section, cutting keyways, burnishing, cutting gear teeth, rifling gun barrels, etc.
	Pull-screw machine	Horizontal or vertical — broach drawn through hole, etc.	
Gear Generator	Fellows	Pinion-shaped cutter, formed shaping tool, etc., used as cutting tool.	Gear cutting.
	Sykes		
	Gleason		
Power Saw	Circular saw	Teeth on periphery of disc.	For cutting bar stock to proper lengths, shaping soft metals, etc.
	Band saw	Teeth on one edge of endless steel band.	
	Hacksaw	Teeth on one edge of short steel band.	
	Friction or abrasive saw	Thin abrasive wheel, etc. — high speed.	Can cut extremely hard material.
Grinder—primarily for surface refinement of finish-machined work	Rough grinding wheel	Work held by hand against coarse abrasive wheel.	Rough removal of stock.
	Surface grinder, horizontal or vertical	Work held by clamp, magnetic chuck, etc., and fed under grinding wheel.	Refinement of flat surfaces.
	Cylindrical grinder	Work rotated between centers against grinding wheel.	Refinement of surface of cylindrical work.
	Universal grinder	Swiveling table, work usually supported on centers.	For tapered surfaces, etc.
	Internal grinder	Work revolved by chuck, abrasive revolved on spindle.	Refinement of internal surfaces.
	Centerless grinder	Work supported between two wheels, one abrasive, the other providing rotation.	For finishing comparatively small cylindrical pieces in mass production.
	Tool grinder	Provision usually made for holding tools at desired angle for rake, clearance, etc.	Sharpening of metal-cutting tools.
Hone	Several types, not well standardized	Fine abrasive stones held against work, internally or externally — comparatively slow rotating and reciprocating motions.	For imparting a very smooth and accurate surface to engine cylinders, bores of guns, cutting edges of tools, etc.
Lapping Machine	Types not well standardized	Fine abrasive powder applied by soft metal or other material, or fine bonded abrasive used.	For imparting an extremely smooth and accurate surface.

Compiled by Kenneth Rose, Engineering Editor

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METALS and ALLOYS

Engineering File Facts

NUMBER 41
March, 1944

PROCESSES AND PROCEDURES
Cleaning

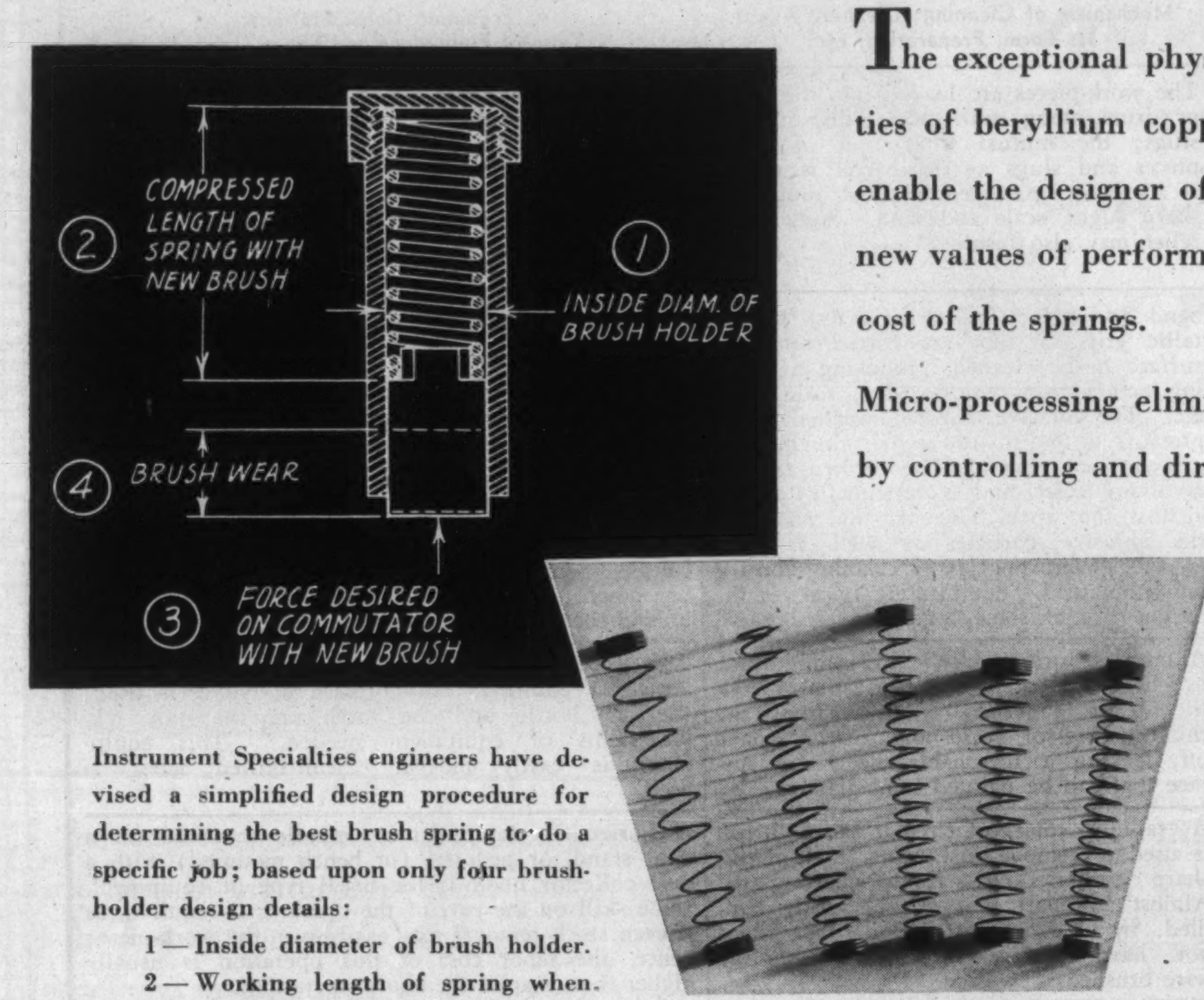
Metal Cleaning—A Comparison of Processes

This section of "Metal Cleaning Processes" is a listing of the mechanical methods for cleaning ferrous metals. Later "File Facts" pages will list the chemical methods (viz: pickling, alkaline and electro-cleaners, etc.) and the cleaning processes for non-ferrous metals and alloys.

Name of Process	Type of Work Handled	Mechanism of Cleaning; Cleaning Agent, Its Form, Preparation, etc.	Economic Considerations; Type of Equipment and Labor Needed
Tumbling	Small castings, and forgings (usually weighing less than 10 lbs.) and stampings.	The work-pieces are loaded into the barrel or drum along with steel balls, stars or slugs; the mutual interaction of work-pieces and slugs as the barrel is rotated at 20 to 60 r.p.m. removes fins, rough and sharp edges, scale and sand. Some stress relief may also result.	This is the cheapest method for cleaning castings and forgings. The equipment includes a rotating horizontal or tilting drum or barrel, usually electrically driven. A variety of types of equipment are available from small hand-loaded, manually-operated barrels to automatic machines for continuous operation. Unskilled labor is used to load, start and stop, and unload the manual units.
Grit, shot and sand blasting	Castings, forgings, stampings, weldments and heat-treated parts of all shapes and sizes.	Sand (or artificial abrasive grits) or metallic grits or shot are forced onto the surface to be cleaned, producing a scouring action that removes dirt, scale, rust, etc. The abrasive may be impelled by air pressure at 60 to 100 p.s.i.; the metallic grit or shot may also be thrown from a revolving wheel and (centrifugally) forced against the work. The size and shape of the abrasive particles as well as their velocity govern the type of cleaning and the finish obtained. Shot blasting improves the fatigue life of some highly stressed parts.	The nozzles have the shortest life of any of the parts of blast cleaning equipment (up to 300 to 400 hr. for tungsten or boron carbide lined nozzles as a maximum). Compressed air is used with the Direct Pressure, Gravity and Suction types of equipment; the Suction type is the least efficient. For metallic grits, a centrifugal device (usually electric-motor-driven) can produce the necessary high velocity particles. This type of equipment is self-contained, being independent of compressed air-lines. Semi-skilled operators handle the manual equipment; unskilled labor is used to load and unload the automatic machinery.
Flame cleaning or flame priming	Large fabricated structures, plates, etc., requiring painting for protective purposes.	A multiple orifice acetylene burning torch or head is used to heat the metallic surface superficially; this causes the thin coating of scale and rust to flake off, leaving a reasonably clean dry surface that can be painted immediately.	This is a quick, economical way to prepare large areas for painting. Compressed acetylene is used; the gas bottle and the torch are the only major items of equipment needed. This equipment is easily moved. Semi-skilled labor is used.
Wire brushing	Small castings, forgings and other metallic parts that may be easily handled.	A rapidly rotating circular wire brush is used to remove rust, scale, tool marks, sharp corners, etc. from small parts. Almost any part that can be easily handled by the operator and that does not have precise dimensions can be wire brushed.	A horizontal, motor-driven spindle mounted on a floor stand, or pedestal (or bench mounted) with a dust collector hood is the usual type of equipment. Some skill on the part of the operator is required, as uneven stock removal may easily ruin the work-piece; hence, the labor cost of this operation is usually higher than that of the above operations.
Vapor degreasing	Small metallic parts up to about 5 lb. in weight.	A succession of immersions in liquid and vaporized chlorinated hydrocarbon solvents (such as trichlorethylene, carbon tetrachloride or perchlorethylene) are used. These solvents will remove oil, dirt and grease but leave traces of organic materials on the work-pieces; hence, an alkaline cleaning operation must follow degreasing if the parts are to be electroplated. Some types of degreasers will only clean relatively massive parts; if a cleaning sequence of boiling liquid, cold liquid and hot vapor is employed, thin or light weight parts can be degreased effectively.	The first cost of solvent is quite high, but it can be used over and over. This process is much more economical if operated continuously. Steam (or electric heating elements) and cold water coils are needed as well as a hood to remove escaping fumes. In general, these solvents are non-inflammable but possess some toxic effects if adequate ventilation is not provided. Usually the work is dipped in the various solvent chambers in basket loads and a chain fall over the degreasing tank is needed. This is a quick and simple operation as the loaded baskets need remain in the degreaser only a few minutes, and no drying or draining is required. Unskilled labor is used to load, unload and clean the parts.
Solvent cleaning	Parts and assemblies requiring removal of grease, oil and/or dirt.	Petroleum solvents (naphtha, gasoline, Stoddard's Solvent, etc.) are used as cleaning agents; these are listed in the order of their toxicity and inflammability. The addition of a small amount of carbon tetrachloride will raise the flash point and reduce the fire hazard. Cleaning is accomplished by dipping the work into one or more solvent baths or by spraying the work with solvent. Grease, drawing compounds, oil, slushing oil, etc. are easily removed by solvent cleaning.	When contaminated with oil, dirt or acid, these solvents must be disposed of, or they may be distilled and reused; the health hazards are not great, but ventilation is required. Work may be racked in baskets and suspended in one or more solvent baths in succession, or the basket may be suspended from a "walking beam" to insure agitation. For high production installations conveyorized spray washers are used. Gentle heating, or a compressed air hose, is used to dry the parts after cleaning. For a few small parts, hand dipping and scrubbing may be used. Unskilled labor is used for these types of solvent cleaning operations.

Compiled by Robert S. Burpo, Jr.

"Micro-Processing" Makes Possible this New Design Concept for Better BRUSH SPRINGS


COMPRESSED LENGTH OF SPRING WITH NEW BRUSH
②
①
INSIDE DIAM. OF BRUSH HOLDER
④ BRUSH WEAR
③ FORCE DESIRED ON COMMUTATOR WITH NEW BRUSH

The exceptional physical and electrical properties of beryllium copper, when Micro-processed, enable the designer of brush springs to establish new values of performance without increasing the cost of the springs.

Micro-processing eliminates all of the guesswork by controlling and directing the inherent properties of beryllium copper to achieve desired new standards of performance in service.

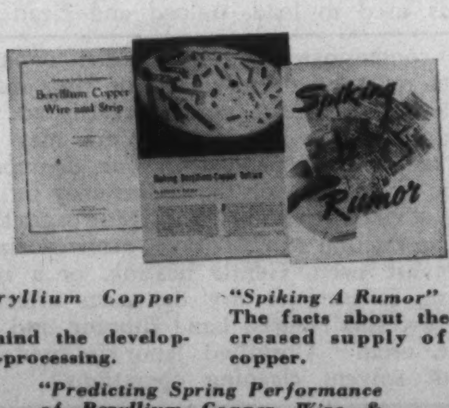
Whether you are interested in the actual design of better brush springs, or desire to improve the working efficiency of equipment and would like I-S to design your brush springs with you, contact us and compare on your own springs — for your own use — the decided difference that Micro-processing makes.

Samples take about a week; quantity deliveries are shipped in 4 to 6 weeks.

Instrument Specialties engineers have devised a simplified design procedure for determining the best brush spring to do a specific job; based upon only four brush-holder design details:

1 — Inside diameter of brush holder.
2 — Working length of spring when assembled with a new brush.
3 — Force desired on the commutator.
4 — Allowance for brush wear.

From these four details of your motor design, I-S engineers will design the one best "Micro-processed" brush spring giving longest brush life consistent with easy assembly.


Beryllium Copper Wire and Strip
Making Beryllium Copper Behave
Spiking A Rumor

"Making Beryllium Copper Behave"
The story behind the development of micro-processing.

"Spiking A Rumor"
The facts about the greatly increased supply of beryllium copper.

"Predicting Spring Performance of Beryllium Copper Wire & Strip"
Why beryllium copper varies in hardening response and what to do about it.

INSTRUMENT SPECIALTIES CO., INC.
DEPT. M-2, LITTLE FALLS, NEW JERSEY

MICRO PROCESSED I-S BERYLLIUM COPPER SPRINGS

FIELD ENGINEERING OFFICES: BOSTON · CHICAGO · CLEVELAND · PHILADELPHIA · NEW YORK

METALS and ALLOYS

Engineering File Facts

NUMBER 42
March, 1944

Copper-Nickel Alloys (5 to 40% Ni)

A Compilation of Common Specifications

Name	Characteristics	Specification	Form or Grade	Composition, Per Cent					
				Cu	Ni	Sn	Pb	Zn	Others (max.)
Cupro-nickel (80-20)	Has high corrosion and heat resistance.	—	Condenser tubes.	80	20	—	—	—	—
Cupro-nickel (70-30)	The greatest resistance to corrosion of all cupro-nickels. Used in marine and oil refinery installations.	ASTM B171,[1] Copper-nickel	Copper - alloy condenser tube plates.	Rem.	29.00-33.00	1.50 max.	0.05 max.	1.00 max.	Mn 1.00 Fe 0.50
		ASTM B111,[2] 70-30 Copper-nickel	Seamless condenser tubes and ferrule stock.	Rem.	29.00-33.00	1.50 max.	0.05 max.	1.00 max.	Mn 1.00 Fe 0.50
		ASTM B122,[3] Alloy No. 5	Sheet and strip.	Rem.	29.00-33.00	1.50 max.	0.05 max.	1.00 max.	Mn 1.00 Fe 0.50
Leadel nickel bronze (leaded nickel silver)	These cast alloys have good machinability and a silvery color. They make good sound corrosion resistant castings.	ASTM B30, Alloy No. 11B	For sand castings.	64.00-66.00	24.00-26.00	4.50-5.50	1.00-2.00	1.00-3.00	Mn 1.00 Fe 0.50
		ASTM B149, Alloy No. 11B	Sand castings.	64.00-67.00	24.00-27.00	4.00-5.50	1.00-2.50	1.00-3.00	Mn 1.00 Fe 1.00
		ASTM B30, Alloy No. 11A	For sand castings.	63.00-65.00	19.50-21.00	3.50-4.50	3.00-5.00	7.00-10.00	Mn 1.00 Fe 1.00
		Fed. WWP 541	Sand castings.	62.0 min.	19.0 min.	2.5 min.	6.0 max.	10.0 max.	Mn 1.00
Nickel brass (nickel silver)	These wrought alloys have good mechanical properties, corrosion resistance and can be hot or cold worked; often used as springs and contacts in electrical apparatus, and sometimes for small caliber bullet jackets.	ASTM B111,[2] 80-20 Copper-nickel Type A	Seamless condenser tubes and ferrule stock.	Rem.	19.0-23.0	1.0 max.	0.05 max.	1.00 max.	Mn 1.0 Fe 0.5
		ASTM B111,[2] 80-20 Copper-nickel Type B	"	Rem.	19.0-23.0	1.0 max.	0.05 max.	3.0-6.0	Mn 1.0 Fe 0.5
		ASTM B122,[3] Alloy No. 6	Sheet and strip.	Rem.	19.0-23.0	1.00 max.	0.05 max.	3.00-6.00	Mn 1.00 Fe 0.50
		ASTM B122,[3] Alloy No. 7	Sheet and strip.	Rem.	19.0-23.0	1.00 max.	0.05 max.	3.00-6.00	Mn 1.00 Fe 0.50
Leaded nickel bronze (leaded nickel silver)	The lead improves the machinability but prohibits heat treatment; has good resistance to corrosion.	ASTM B149 Alloy No. 11A	Leaded nickel-bronze sand castings.	63.00-67.00	19.50-21.50	3.50-4.50	3.00-5.00	6.00-10.00	Mn 1.00 Fe 1.00
Nickel brass (nickel silver)	A pleasing white color; can be stamped, spun, cold - formed and drawn, or hot forged; they have good corrosion resistant qualities; used in condenser tubes and chemical piping.	SAE 42	White nickel brass castings.	55.00-64.00	18.00 min.	—	—	Rem.	Fe 0.35
		ASTM B122,[3] Alloy No. 1	Copper-nickel alloy sheet and strip.	70.5-73.5	17.0-19.5	—	0.10 max.	Rem.	Mn 0.50 Fe 0.35
		ASTM B122,[3] Alloy No. 2	"	63.0-66.5	17.0-19.5	—	0.10 max.	Rem.	Mn 0.50 Fe 0.35
		ASTM B122,[3] Alloy No. 4	"	53.5-56.5	17.0-19.5	—	0.10 max.	Rem.	Mn 0.50 Fe 0.35
	General purpose material in several tempers.	ASTM B151,[4] Alloy A	Copper - nickel - zinc alloy rod and wire.	63.0-66.5	17.0-19.5	—	0.05 max.	Rem.	Mn 0.50 Fe 0.25
	Generally used in the hard temper.	ASTM B151,[4] Alloy B	"	53.5-56.5	17.0-19.5	—	0.05 max.	Rem.	Mn 0.50 Fe 0.25
	Machinability better than alloys A or B.	ASTM B151,[4] Alloy C	"	60.0-65.0	17.0-19.5	—	0.75-1.25	Rem.	Mn 0.50 Fe 0.25
Leaded nickel brass (leaded nickel silver)	Used where corrosion resistance and / or pressure tightness is needed. Plumbing and architectural fixtures and fittings.	ASTM B30, Alloy No. 10B	Copper-base ingot for sand castings.	58.00-61.00	15.50-17.00	2.50-3.50	4.50-5.50	Rem.	Mn 0.50 Fe 1.00
		ASTM B149, Alloy No. 10B	Leaded nickel brass sand castings.	57.00-62.00	15.00-17.50	2.25-3.75	4.25-5.75	Rem.	Mn 0.50 Fe 1.50
		ASTM B149, Alloy No. 10A	"	53.00-58.00	11.00-14.00	1.50-3.00	8.00-11.00	Rem.	Mn 0.50 Fe 1.50
		ASTM B30, Alloy No. 10A	Copper-base ingot for sand castings.	53.00-58.00	11.00-14.00	1.50-3.00	8.00-11.00	Rem.	Mn 0.50 Fe 1.00
	A general purpose alloy.	—	Sand castings.	Rem.	5.0-5.5	5.0-5.5	nil	1.0-2.0	P 0.03-0.05

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[1] Emergency Alternate Spec. ASTM EA-B171 provides for the same compositions as ASTM B171, but fire-refined copper, ASTM ES-7, may be used instead of ASTM B4 or B5. [2] Emer. Alt. Spec. ASTM EA-B111 provides for the same compositions as ASTM B111, but fire-refined copper, ASTM ES-7, may be used instead of ASTM B4 or B5. [3] Emer. Alt. Spec. ASTM EA-B122 provides for the same compositions as ASTM B122, but fire-refined copper, ASTM ES-7, may be used instead of ASTM B4 or B5. [4] Emer. Alt. Spec. ASTM EA-B151 provides for the same composition as ASTM B151, but fire-refined copper, ASTM ES-7, may be used instead of ASTM B4 or B5.

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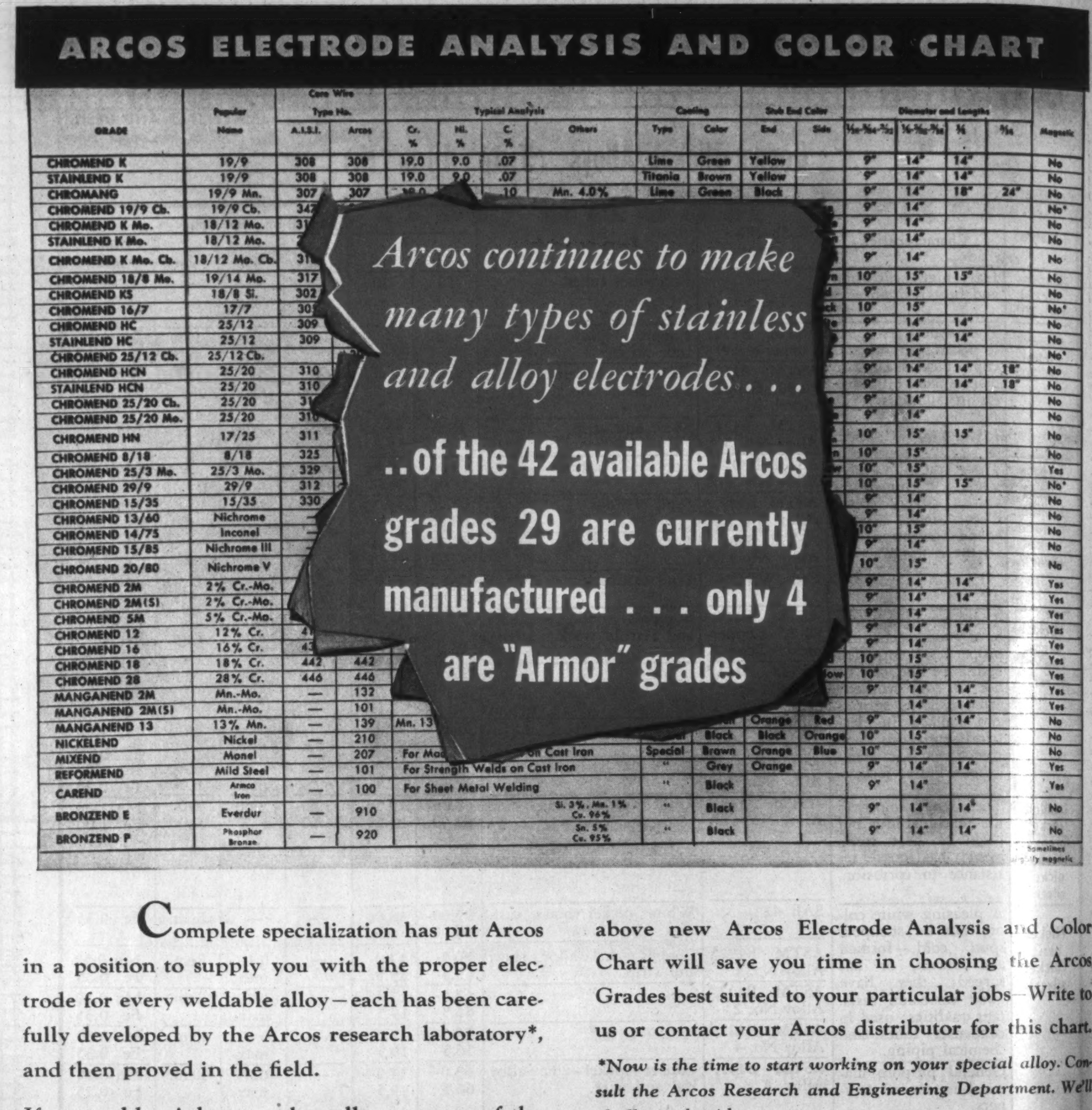
Arcos continues to make many types of stainless and alloy electrodes . . .
..of the 42 available Arcos grades 29 are currently manufactured . . . only 4 are "Armor" grades

ARCOS ELECTRODE ANALYSIS AND COLOR CHART

GRADE	Popular Name	Core Wire Type No.		Typical Analysis				Coating		Stub End Color		Diameter and Lengths				Magnetic
		A.I.S.I.	Arcos	Cr. %	Ni. %	C. %	Others	Type	Color	End	Side	1/16-5/64-3/32	1/8-5/32-3/16	1/4	5/16	
CHROMEND K	19/9	308	308	19.0	9.0	.07		Lime	Green	Yellow		9"	14"	14"		No
STAINLEND K	19/9	308	308	19.0	9.0	.07		Titania	Brown	Yellow		9"	14"	14"		No
CHROMANG	19/9 Mn.	307	307	[illegible]	[illegible]	.10	Mn. 4.0%	Lime	Green	Black		9"	14"	18"	24"	No
CHROMEND 19/9 Cb.	19/9 Cb.	347	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No*
CHROMEND K Mo.	18/12 Mo.	31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
STAINLEND K Mo.	18/12 Mo.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND K Mo. Cb.	18/12 Mo. Cb.	31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND 18/8 Mo.	19/14 Mo.	317	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"	15"		No
CHROMEND KS	18/8 Si.	302	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	15"			No
CHROMEND 16/7	17/7	30	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			No*
CHROMEND HC	25/12	309	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"		No
STAINLEND HC	25/12	309	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"		No
CHROMEND 25/12 Cb.	25/12 Cb.		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No*
CHROMEND HCN	25/20	310	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"	18"	No
STAINLEND HCN	25/20	310	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"	18"	No
CHROMEND 25/20 Cb.	25/20	31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND 25/20 Mo.	25/20	31	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND HN	17/25	311	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"	15"		No
CHROMEND 8/18	8/18	325	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			No
CHROMEND 25/3 Mo.	25/3 Mo.	329	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			Yes
CHROMEND 29/9	29/9	312	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"	15"		No*
CHROMEND 15/35	15/35	330	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND 13/60	Nichrome	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND 14/75	Inconel	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			No
CHROMEND 15/85	Nichrome III	—	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			No
CHROMEND 20/80	Nichrome V	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			No
CHROMEND 2M	2% Cr.-Mo.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"		Yes
CHROMEND 2M(5)	2% Cr.-Mo.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"		Yes
CHROMEND 5M	5% Cr.-Mo.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			Yes
CHROMEND 12	12% Cr.	41	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"		Yes
CHROMEND 16	16% Cr.	43	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"			Yes
CHROMEND 18	18% Cr.	442	442	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			Yes
CHROMEND 28	28% Cr.	446	446	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	10"	15"			Yes
MANGANEND 2M	Mn.-Mo.	—	132	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9"	14"	14"		Yes
MANGANEND 2M(5)	Mn.-Mo.	—	101	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			14"	14"		Yes
MANGANEND 13	13% Mn.	—	139	Mn. 13 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Orange	Red	9"	14"	14"		No
NICKELEND	Nickel	—	210	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Black	Black	Orange	10"	15"			No
MIXEND	Monel	—	207	For Mo [illegible] on Cast Iron				Special	Brown	Orange	Blue	10"	15"			No
REFORMEND	Mild Steel	—	101	For Strength Welds on Cast Iron				"	Grey	Orange		9"	14"	14"		Yes
CAREND	Armco Iron	—	100	For Sheet Metal Welding				"	Black			9"	14"			Yes
BRONZEND E	Everdur	—	910				Si. 3%, Mn. 1% Cu. 96%	"	Black			9"	14"	14"		No
BRONZEND P	Phosphor Bronze	—	920				Sn. 5% Cu. 95%	"	Black			9"	14"	14"		No

* Sometimes slightly magnetic

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Cleveland, Ohio	Williams & Co., Inc.
Columbus, Ohio	Williams & Co., Inc.
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Honolulu, Hawaii	Hawaiian Gas Products, Ltd.
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Kingsport, Tenn.	Slip-Not Belting Corp.
Los Angeles, Calif.	Victor Equipment Co.
Milwaukee, Wis.	Machinery & Welder Corp.
Moline, Ill.	Machinery & Welder Corp.
Montreal, Canada	G. D. Peters & Co. of Canada, Ltd.
New Orleans, La.	Wm. D. Seymour Co.
New York, N. Y.	H. Boker & Co., Inc.
Oklahoma City, Okla.	Hart Industrial Supply Co.
Pampa, Texas	Hart Industrial Supply Co.
Pittsburgh, Pa.	Williams & Co., Inc.
Rochester, N. Y.	Welding Supply Co.
San Diego, Calif.	Victor Equipment Co.
San Francisco, Calif.	Victor Equipment Co.
Seattle, Wash.	Victor Equipment Co.
St. Louis, Mo.	Machinery & Welder Corp.
Syracuse, N. Y.	Welding Supply Co.
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METALLURGICAL ENGINEERING
shop notes

Non-Slip Bracket for Rivets

by Theodore D. Caplinger,
Curtiss-Wright Corp.

A new non-slip bracket eliminates marring and dimpling of aluminum skins by the mushroom rivet set, and allows the riveter to buck his own rivets in accessible locations. It was adjusted so that the rubber suction cups extend somewhat beyond the rivet set, allowing the spring action of the bracket to disengage the rivet set.

Adjustment is made by screwing the bracket on the spring up or down until the desired tension is secured. The bracket is placed straddling the rivet, and pressure is applied to set the rubber suction cups. The operator rivets by pressing the rivet set against the pressure of the spring bracket to contact with the rivet head.

The bracket provides a fixed guide for all practicable purposes directly over the rivet head, and prevents the set from skidding off the rivet head.

Previously, the mushroom rivet sets used in riveting flush-type rivets had a tendency to skid off the rivet head and mar the part to be riveted. The operation required two men at all times, because the riveter was unable to buck his own rivets with the standard set.

[The author, connected with the Columbus branch of Curtiss-Wright, won a national award certificate from the War Production Board for this idea. In the accompanying photograph the author is demonstrating it.—Editor]

Metallizing a Gouged Shaft

by Paul Ziegler

While in operation, the outside left bearing on the main axle of an Adams road grader broke. Before the damage was discovered, the broken bearing had severely gouged the shaft.

We figured that to repair by welding would give unfavorable heat treatment or warp the part. A new 300-lb. shaft would have cost $750 and entail 5 day's labor, and it might be impossible to get the shaft.

Metallizing was therefore decided on. A lathe compound was rigged on the rear housing, enabling us to prepare, spray and finish the gouged area without removing the shaft. Using a standard tool bit, the section was grooved and then built up with 1 lb. of sprayed "Sprasteel" No. 20, the spraying requiring 20 min.

After metallizing, original dimensions were obtained by machining and, finally, by finishing with a file. Throughout these operations the shaft was turned under its own power.

This shaft has been in service for over two years, and when examined early this year the metallized section was in excellent condition.

Much has been written on how best to put to use welding electrode stubs. Perhaps one of the most novel is to give them to welding schools for practice work. A member of the New York Board of Education and a certain manufacturer got together by accident and evolved the idea. The manufacturer explained that in a certain production job it is impossible to use more than 8 in. of a 14-in. electrode. Material to be welded is placed on a revolving, mechanically-driven fixture and, because of automatic and continuous nature, it is always most economical to start each routine with new electrodes. "Orphan" stubs are best given away.

—General Electric Co.

Salt Bath Furnace for Aircraft

by F. K. Whiteside,
Brooklyn Union Gas Co.

A large gas-fired, salt bath, aluminum heat-treating furnace was recently installed in the new shops of Pan American World Airways at La Guardia Field, New York, for repairing large flying boats. By annealing and hardening aluminum alloy parts on the spot, much valuable time can be saved.

Sheets up to 14 ft. long and 4 ft. wide can be handled. Intermittency of its use dictated firing with gas fuel.

The pot containing the salt bath is 14 ft. long, 2½ ft. wide and 5 in. deep on the inside. The radiant burners are the all-ceramic Duradiant Selas, 44 in number. The pot weighs 5,500 lb., holding ten tons of sodium and potassium nitrates, with melting point of 425 F. Operating temperatures range between 650 F. for annealing and 920 F. for solution heat treating.

The design of the cup of the burners is such that the products of combustion swirl back toward the burner tip in a sort of involute curve, not issuing from the burner at a high velocity or in a direct straight line. Hence, burners could be placed only 8 in. from the pot. The combustion products soon raise the burner cup to incandescence and provide the radiant heat.

When heating the furnace up from a cold start to 920 F., 70% of the B.t.u.'s are effectively utilized in heating the pot and salts. At no time during the heating up period do the pot sides become overheated. Thus, if the burners are shut off when the salt bath approaches 920 F., only by closest scrutiny can any color be detected in the furnace or pot walls.

So complete is the absorption of heat by the salt that, while heating up, the products of combustion leave the furnace at a temperature not exceeding 100 F. higher than that of the salt.

Each group of burners is supplied with its properly proportioned mixture of air and gas by a Selas low pressure proportional mixture and individual zero regulator on the gas line. Air is supplied by a Spencer Turbo compressor at 24 oz. pressure.

Gas is a mixture of coke oven and carbureted water gas, with heating value of 540 B.t.u. per cu. ft. and 0.60 s.g. The furnace has an hourly gas demand of 4500 cu. ft. and can be heated, cold to 920 F., in less than 5 hr.

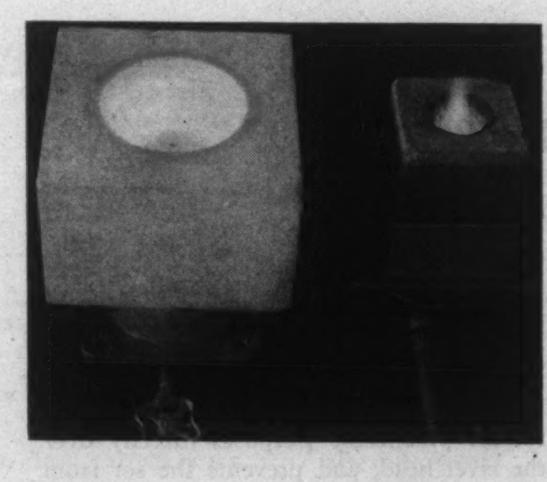
The salt bath temperature can be controlled automatically within ± 5 F. by operating on the lowest 12 burners. Efficient heat storage by the salt is shown by the seven days required for its temperature to drop 700 F.

A satisfactory piloting system was worked out by applying small sealed-in pilot burners to the 16 Duradiant burners at the uppermost level. For flexibility, the furnace is provided with five individually hinged and counter-weighted covers, furnishing an opening varying between 3 ft. and 14 ft. in length.

All materials for the installation were supplied by Pan American World Airways, who performed all labor except the installation of the pot, which was done by professional riggers.

In one of the accompanying photographs is seen the front of the furnace, showing the burners and proportional mixers. Note the pilots on the uppermost burners.

In the other photograph is seen the ceramic-cup radiant gas burner (left) during throttled operation, installed in this furnace, as compared with the typical conventional single-port burner (right) operating at the same input, air-gas ratio, etc. At the left note the uniformity of incandescence in the cup and absence of flame beyond the burner face.



Example of Bad Safety Precaution

by the National Safety Council

In every shop a workman should have a two-fold purpose: To produce efficiently the desired product, and to do this carefully, so that he will be safe and sound to produce another day.

An electric welder, starting work, found that the arc was not hot enough, and asked a nearby pipefitter foreman to step up the machine. He took hold of a wheel on top but was immediately so shocked with 440 v. that he was unable to let go of the wheel. Death resulted.

The investigation that followed revealed that the 440 v. lead-in was bare at the machine, that the bare part of the wire touched the frame of the machine, that the machine was completely insulated as it stood on wooden blocks and hence no part was grounded, and, finally, that the employee's shoes were wet and muddy.

It is obvious from the above what do's and don'ts apply here. The most important rule is that only experienced operators should operate or make adjustments.

A portable vacuum cleaner speeded up cleaning of carburizing retorts by hours.
Informative Technical Bulletin,
No. 10, War Production Board

Monel Screen Welded to Pipe

by Walter J. Czyz

Our problem was to weld 16-mesh Monel screens to the ends of standard steel 1¼-in. pipes, about 4 in. long. Arc welding is the normal procedure, but without special provision the somewhat delicate mesh would be destroyed by the electric arc.

Therefore, a special welded jig was devised for the purpose. A section of the screen was cut somewhat larger than the outside diameter of the pipe and cupped with the fingers so that it would not lie flat and the finished screen would be slightly dome-shaped. Then the screen was laid on a piece of copper, 3 x 3 in. and ¼ in. thick.

Next, the pipe was placed on the screen and clamped down by the welding jig, as shown in the accompanying sketch. With a 3/32-in. Monel electrode a weld was put around the base of the pipe, with the welder set at around 11-amp.

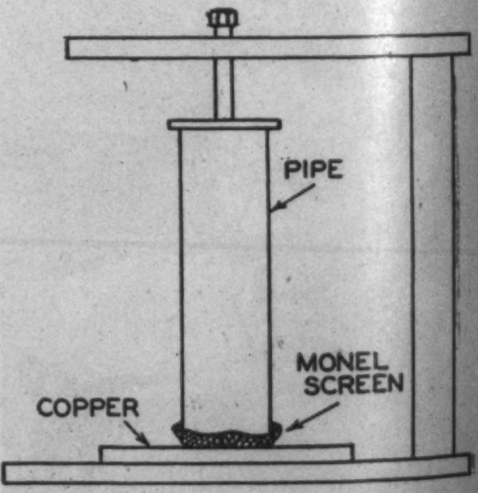
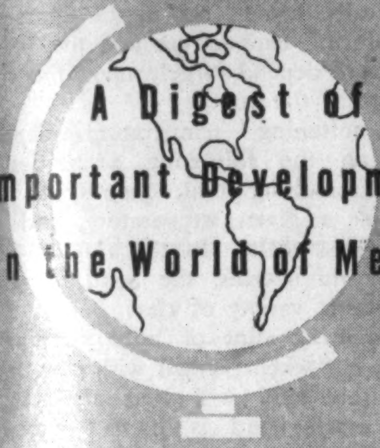


FIG. I

Now the work was removed from the jig and the screen bowed out slightly and trimmed to the pipe diameter.

—Lincoln Electric Co.

Metallurgical Engineering Digest



A Digest of
Important Developments
in the World of Metals

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1

Metal Production

Blast Furnace Practice, Smelting, Direct Reduction and Electrorefining • Open-Hearth, Bessemer, Electric Furnace Melting Practice, Equipment and Refractories • Melting and Manufacture of Non Ferrous Metals and Alloys • Soaking Pits and other Steel-Mill and Non-Ferrous Mill Heating Furnaces • Steel and Non-Ferrous Rolling, Wire Mill, Pickling and Heavy Forging Practice

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Steel Industry Refractories

Condensed from "Blast Furnace and Steel Plant"

The iron and steel industry demands refractories of very widely differing qualities and requirements. Among the properties that must be considered are thermal conductivity, thermal expansion, load carrying capacity at high temperatures, abrasion resistance, and resistance to gases, metals, slags, fluxes, and other materials.

Fire-clay brick constitutes the largest class of refractories consumed, and contain from 30 to 50% alumina. In fabricating refractories, it is generally necessary to use a bond of plastic and generally lower-fusing nature with the highly resistant, mechanically strong, non-plastic aggregate. The maturing temperature and the life of a refractory depend largely upon the characteristics of the bond.

The softening temperature depends largely on the following properties of the bond: melting-point, quantity of melt formed at a given temperature, and viscosity of the melt. In the alumina-silica series of refractories, the bond is generally a plastic variety of clay.

The melting-point of pure alumina is 3722 F., but when bonded with clay, melting of the bond will start at 2813 F. If too much bond is present excessive softening will occur at the latter temperature. If the refractory contains more than 72% alumina, permanent liquid formation will not occur below 3290 F.

Silica brick are the next most widely used class of refractories. They are used for the roofs of open-hearth furnaces, linings of cupolas and acid open-hearth furnaces, and in coke-ovens and gas-retorts.

They are usually bonded with a small amount of lime, instead of clay. With lime, liquid formation takes place at somewhat lower temperatures than is the case with an equivalent amount of alumina.

However, the proportion of liquid formed is much less at 2900 F. in the lime-silica system than in the alumina-silica system, and the increase of liquid with rising temperature will be much less in the former. With lime, the entire system becomes liquid at 3088 F., two immiscible liquids forming. The second liquid is very high in silica, and behaves more like a solid.

Quartz expands fairly rapidly but steadily up to 1067 F. and then there is a sudden expansion, caused by an inversion to a high temperature modification. Between 1598 F. and 2678 F., quartz is transformed to tridymite in the presence of a flux. In a silica brick, the lime acts to promote this transformation.

Above 2678 F., cristobalite is the stable form of silica. Expansion of tridymite above 225 F. is gradual and considerably lower than that of the other crystalline forms of silica. Thus, a silica brick with a fairly high proportion of tridymite is a rather stable refractory, and will not rupture readily because of sudden changes in temperature.

Domestic Material Used

Magnesite has the highest melting-point (5072 F.) of the common refractory oxides, and is basic in character. Until the first

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NOW OFFERS
..IT'S GRANULAR!

DUSTLESS
DENSE
SODA ASH
No. 2-10

A new form of SOLVAY Dustless Dense SODA ASH created especially for desulfurization is now available.

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SOLVAY SALES CORPORATION

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Can Your Refractory Coating Stand This Test?

1—Coat a sample brick.
2—Heat to 3000° F.
3—Plunge hot brick into cold water.

No refractory coating is ever actually subjected to such abuse, but it proves that Brickseal can take it.

Brickseal is a combination of high-fusion clays, metal oxides and oils. It is applied like paint with brush or gun, and the furnace can be fired immediately. Heat burns off the oils and vitrifies the inert materials, forming a highly-glazed, air-tight, monolithic coating integral with the lining. Unlike the plaster-like surface coating formed by air-set washes, Brickseal penetrates deeply into brick pores, joints and cracks, sealing them against infiltration of carbon and gases which cause spalling and cracking. Under heat, Brickseal is sufficiently plastic to expand and contract with the wall, and will not crack, peel or blister due to sudden changes in temperature.

Brickseal protects your furnace against untimely refractory failure and keeps it operating at top efficiency. Its cost is relatively insignificant. Write for Brickseal sample.

BRICKSEAL
REFRACTORY CO.
1029 CLINTON ST., HOBOKEN, N. J.

World War, Austrian magnesite was used almost universally in the United States for basic open-hearth furnaces. Now, both magnesite and dolomite refractories are used.

Pure magnesite is so refractory that ordinary furnace heat treatment does not completely shrink it and it is difficult to bond. For this reason, domestic magnesite, which does not have sufficient impurities present to act as fluxes for this purpose, requires the addition of small amounts of fluxing ingredients during calcination.

During the last few years, magnesium oxide derived from sea water or from the reaction of sea water with calcined lime or dolomite has been used as a refractory.

Calcined dolomite is cheap, but its lime content slakes rapidly on contact with air. Also, uncombined lime is not a permanent part of the refractory bottom of an open-hearth furnace. Clinkered dolomite can be improved greatly by proper incorporation of fluxes during calcination.

Refractories intermediate between dolomite and magnesia can be produced by adding high magnesia raw materials to dolomite prior to calcination. A recent development is to incorporate sufficient silica with the dolomite to combine with the calcium oxide and form calcium orthosilicate, leaving the magnesia substantially uncombined as periclase.

Refractory quality of the bottom decreases while in service, and the working surface is gradually corroded during the progress of the heat. Therefore, it is necessary to shape up the hearth between heats. Clinkered dolomite or raw or calcined dolomite is used for this purpose because it sinters into place rapidly and is cheap.

Silicon carbide has high thermal conductivity at all temperatures and good spalling resistance. Sillimanite and kyanite are more refractory than clay. Graphite is one of the most refractory substances known, but is limited in use by its tendency to oxidize at moderately high temperatures.

Oxides and compounds of zirconium, thorium, and beryllium are very refractory, but their high cost limits their use.

—Henry G. Fisk, *Blast Furnace & Steel Plant*, Vol. 31, Dec. 1943, pp. 1385-1390, 1424.

Desulphurization with Acid Slags

Condensed from "Archiv Eisenhüttenwesen"

New experiments on the desulphurization of pig iron with acid blast-furnace slags led to the conclusion that the strong desulphurizing action that acid slags can exert at high temperatures (1700° C.) (3100° F.) goes on only to a very small extent through the silicon sulphide escaping as gas.

The initially acid slags produce a considerable desulphurization of the pig iron if the latter has absorbed very high but technically not permissible silicon contents (>4%) and, therefore, the final slags have become considerably more basic. The greatest amount of sulphur, almost always more

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- **Rite-Melt Cleanser**— containing no aluminum—placed on bottom of ladle or into stream or on bottom of mold.
- **Rite-Sulphur Reducer**—put in ladle.
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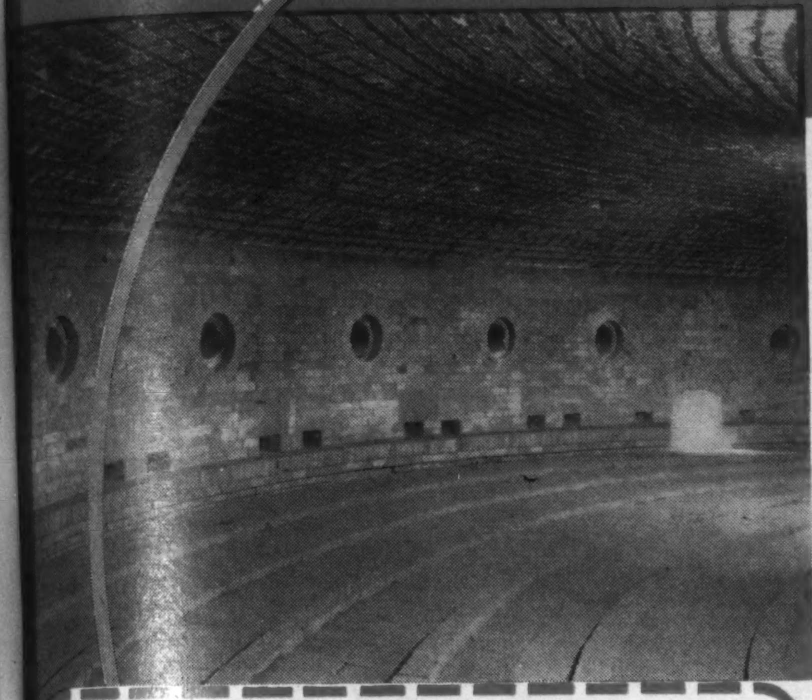

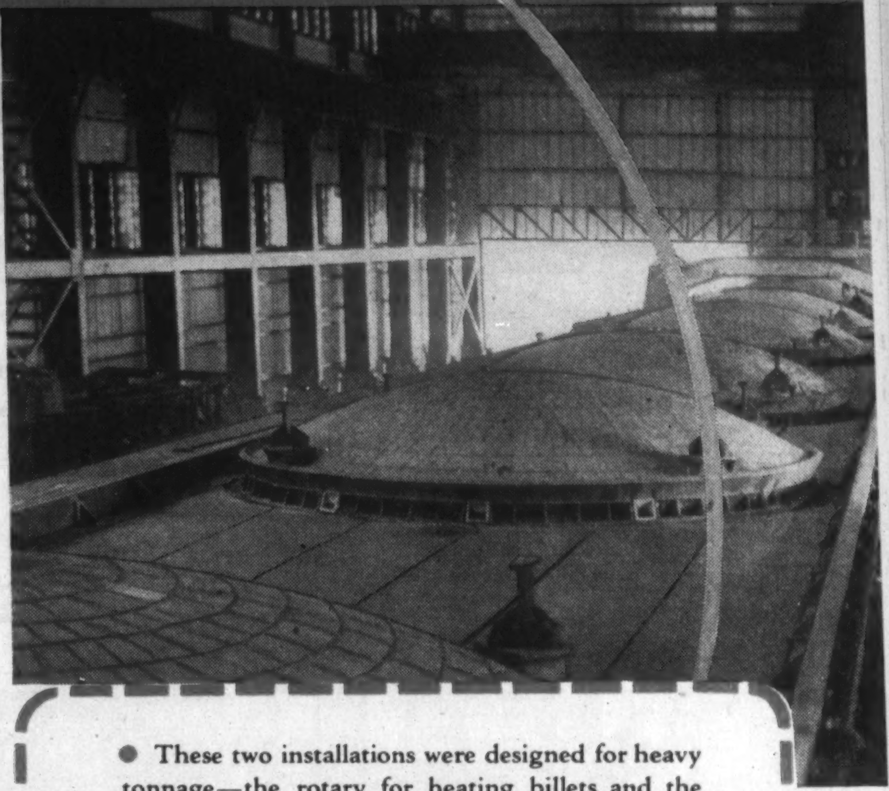

- The inside surface of the outside wall on the world's largest rotary furnace shows the firing and exhaust ports as well as piers of the rotating hearth (effective area of 2100 sq. ft.) on which billets rest.

The temperature for each of the five zones in the furnace is automatically recorded on a dial chart which in conjunction with a loading record chart enables the operator to determine the temperature and locate the position of any billet at any time during the heating period. The hearth is equipped with a variable speed mechanism which gives a range of 2 to 8 hours per revolution.

- These two installations were designed for heavy tonnage—the rotary for heating billets and the soaking pits for heating ingots. Both have these points in common—burn the same type of fuel (gas with oil standby), operate in same temperature range, have finger-tip controls, and a multiplicity of burners. Both installations have been in places long enough to prove our original operating economy claims. In each instance, the customer is enthusiastic about the results.

Perhaps you should consider a Salem rotary furnace or a Salem circular soaking pit for your next installation. Our engineers can supply the data.

Write SALEM for Complete Data

- The circular design in a soaking pit provides these sixteen advantages: (1) faster heating rate; (2) remarkable heat uniformity; (3) better rolling; (4) better steel; (5) less scale; (6) less chipping; (7) 1% higher yield; (8) a very minimum of cinder; (9) less fuel consumption; (10) no flame impingement on ingots or the furnace wall; (11) no washing of ingots; (12) less maintenance; (13) lower fuel expense; (14) foolproof cover for greater safety; (15) higher production in a given area; (16) lower over-all production costs.

SALEM ENGINEERING COMPANY

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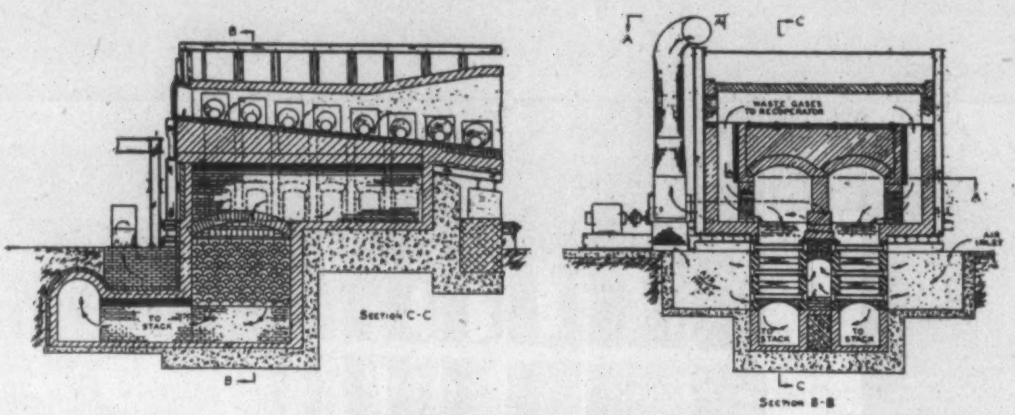
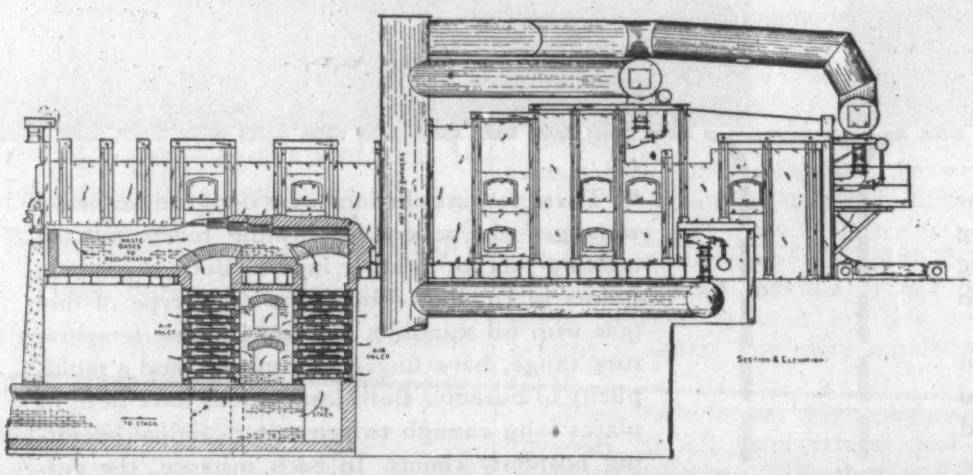
"FITCH" RECUPERATORS For HEATING FURNACES



One of five continuous billet heating furnaces in a seamless pipe mill equipped with a "Fitch" recuperator. Fuel savings up to 30% are obtained with the recuperator.



One of the two continuous slab heating furnaces in a strip mill equipped with a "Fitch" recuperator. Each furnace has a maximum capacity of 80 tons per hour.

Other successful installations include the conversion of regenerative batch type slab heating furnaces to recuperative furnaces resulting in a greatly increased capacity.

●

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Write for Bulletin No. 12

●

"FITCH" RECUPERATORS for the STEEL INDUSTRY

FITCH RECUPERATOR CO.

PLAINFIELD NATIONAL BANK BLDG. PLAINFIELD, NEW JERSEY

than 70% of the total amount, remains after desulphurization in these more basic final slags.

An extension of the duration of the reaction results in an increase of the silicon content of the pig iron, and thus of the basicity of the slag and, consequently, in very low sulphur contents of the pig iron.

The evaporated amounts of sulphur, about 30% of the total original amount are very small compared with the desulphurization caused by the more basic final slags, from about 0.6% to 0.01% S. With reduced amounts of slag, desulphurization becomes considerably worse.

W. Oelsen & H. Maetz. *Arch. Eisenhüttenw.*, Vol. 16, Feb. 1943, pp. 283-298.

Continuous Casting

Condensed from "Metal Treatment"

Batteries of continuous casting machines are known to be in operation at various works in Kassel, Ulm, and Bitterfield; and at Stuttgart the inventor of one type of continuous casting machine, Siegfried Junghans, is producing bars in most metals up to 20 in. in diam.

The Junghans machine, the most adaptable and effective of all, is a modification of an early type built and operated 85 years ago by Sir Henry Bessemer in St. Pancras, London, England, and employs the principle of pouring metal through an open mold. The cost is considerably less than 1% of that of a modern re-rolling or extruding unit.

The metal is forced by nitrogen under pressure from an induction heated holding furnace to a reservoir, from which it flows by gravity into a water-cooled open-bottomed mold from which the solidified bar is drawn, cooled further by sprays, and cut to lengths. The outstanding feature of the unit is the oscillatory movement imparted to the water-cooled mold.

The mold, together with the partly emergent bar, travels downwards for about 1¾ in. and then the mold snaps back to its uppermost position at a speed 3 to 4 times faster. Ordinary drawn copper tubing is used as a mold and the oscillatory movement ensures that the walls are always clean and free from pitting and scale. The cooling action is such that the bar loses its heat outward and the skin solidifies while the interior is still molten. A unit of this type is producing 560 tons of brass bar per week at the Scovill works in Waterbury, Conn.

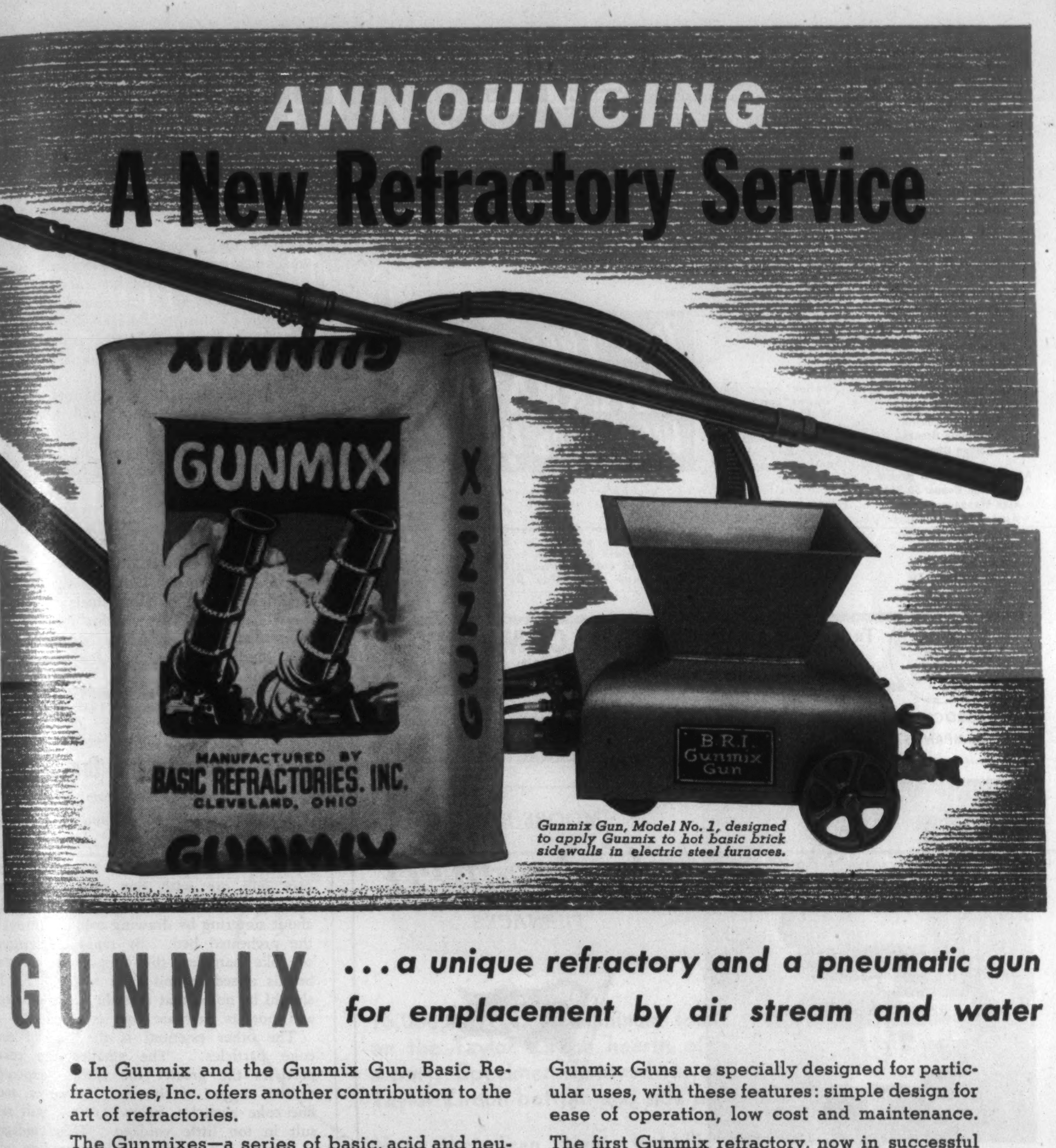
Other American Machines

The Williams machine, operating at the Vulcan Mold and Iron Co., Latrobe, Pa., is similar in principle, but special attention is given to the method of cooling the mold, which does not oscillate. Pinch rolls withdraw the bar downwards at 7 to 10 ft. per min., producing 6 in. rounds and 4 in. squares in alloy steels.

The Eldred machine, while similar in its basic principle, uses a mold made of a relatively non-conducting material, such as graphite or carborundum; and the heat is extracted solely by way of the solid bar already extruded, which is cooled by water

ANNOUNCING

A New Refractory Service



Gunmix Gun, Model No. 1, designed to apply Gunmix to hot basic brick sidewalls in electric steel furnaces.

GUNMIX

. . . a unique refractory and a pneumatic gun for emplacement by air stream and water

● In Gunmix and the Gunmix Gun, Basic Refractories, Inc. offers another contribution to the art of refractories.

The Gunmixes—a series of basic, acid and neutral refractories designed for emplacement by air stream and water—represent just as great a departure from conventional refractory practice as was introduced 5 years ago with Ramix, the cold-ramming basic hearth refractory.

Gunmix refractories have these distinctive, outstanding properties:

1. High refractoriness.
2. Rapid coalescence with hot surfaces.
3. Ready adherence to vertical walls.

Gunmix Guns are specially designed for particular uses, with these features: simple design for ease of operation, low cost and maintenance.

The first Gunmix refractory, now in successful use, is a basic refractory intended primarily for maintenance of basic sidewalls of electric steel furnaces. Gunmix Gun Model No. 1, illustrated above, has been designed for this particular application. Other models will follow.

Many months in development, these new Gunmix refractories give promise of wide application in furnaces of many types. Your interest and your suggestions as to other possible uses for Gunmix will be welcomed.

BASIC FURNACE
REFRACTORIES

BASIC REFRACTORIES, INCORPORATED *Cleveland, Ohio*

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NOTE

*"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

●

Send for booklet
"INGOT METALS OF TODAY"

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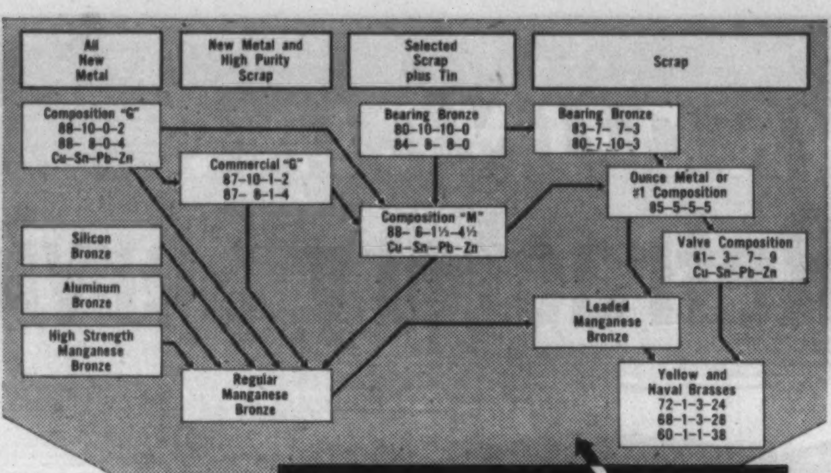
16 STANDARD INGOT METALS BY AJAX

Ajax Tombasil
Ajax Plastic Bronze
Ajax Anti-Acid Bronze
Ajax Phosphor Bronze
Ajax Red Brass Ingots
Ajax Manganese Bronze
Ajax High-Tensile Manganese Bronze
Ajax Golden Glow Yellow Brass
Ajax-Hamilton Gear Bronze
Ajax Nickel-Copper 50-50%
Ajax Manganese Copper
Ajax Aluminum Alloys
Ajax Phosphor Copper
Ajax Silicon Copper
Ajax Nickel Alloys
Ajax Phosphor Tin


All New Metal
New Metal and High Purity Scrap
Selected Scrap plus Tin
Scrap
Composition "G" 88-10-0-2 88- 8-0-4 Cu-Sn-Pb-Zn
Commercial "G" 87-10-1-2 87- 8-1-4
Bearing Bronze 80-10-10-0 84- 8- 8-0
Bearing Bronze 83-7- 7-3 80-7-10-3
Ounce Metal or #1 Composition 85-5-5-5
Composition "M" 88- 6-1½-4½ Cu-Sn-Pb-Zn
Valve Composition 81- 3- 7- 9 Cu-Sn-Pb-Zn
Silicon Bronze
Aluminum Bronze
High Strength Manganese Bronze
Regular Manganese Bronze
Leaded Manganese Bronze
Yellow and Naval Brasses 72-1-3-24 68-1-3-28 60-1-1-38

Use These
ALTERNATIVES
Wherever You Can

Notice how the arrows on the W.P.B. chart point to the *right*. . . . They show how alternative materials *currently available* can be utilized by foundrymen as now permitted by many designers. The purpose is to conserve primary metal at the mine through increased use of secondary ingots. Sometimes great ingenuity is called for, yet remember this:

The first program for scientific control of ingot metal was set up by Ajax 46 years ago. The result has been metal and practical technical follow-through in which Ajax increases your production by reducing rejects.

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ESTABLISHED 1880
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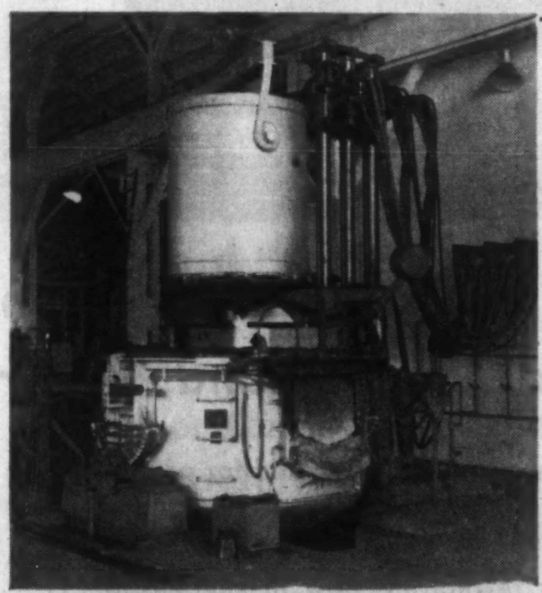

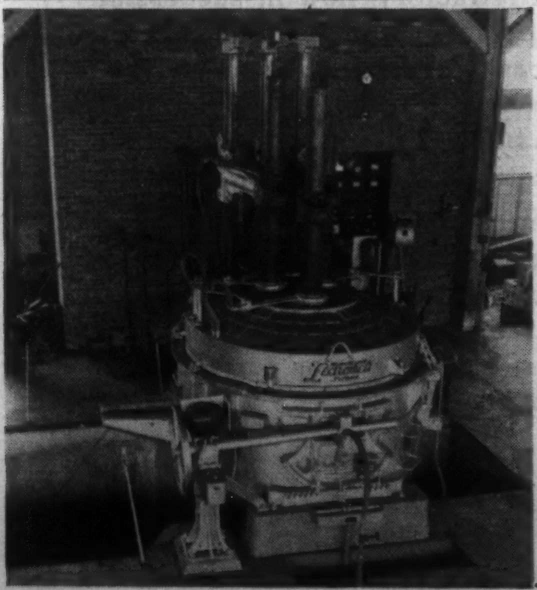

MOORE RAPID
Lectromelt
FURNACES

ARMY E NAVY

Illustrated are two three ton capacity Lectromelts of the top charge type. These furnaces are used extensively because they operate with lower power consumption and save in electrode and refractory costs. Write for detailed information.

Pittsburgh Lectromelt Furnace Corp.
PITTSBURGH, PENNSYLVANIA

sprays. Production rates are thus relatively slow, but the structure of the bars is uniform, there is no surface skin, and surface blemishes are absent.

The Poland-Lindner machine resembles the Eldred machine, but uses a mold built of a thin wall of graphite entirely surrounded by water and so has a greater output rate. A unit is in operation at the Rahway, N. J., plant of the American Smelting and Refining Co.

A second group of continuous casting machines employs two turning rolls instead of a fixed roll, a well known example being the Hazelett A machine. The disadvantage of this machine is that, since the metal is compressed by the rolls before it is completely solid, folding and lapping of the partially chilled material occurs and low-melting constituents are forced to the places of low pressures and least chill. However, strip up to 12 in. wide is in production at speeds of 15 to 50 ft. per min. at the works of the Scovill Manufacturing Co.

These troubles have been largely overcome in the Hazelett B machine by the use of a separate cooling ring, on which the metal is completely chilled before it is compressed by contact with the surface roll. Stainless and other alloy steels as well as brass have been cast on this machine. A somewhat similar principle is employed in the Merle machine, but few details are available.

—Leslie H. Day. *Metal Treatment,* Vol. 10, Autumn 1943, pp. 173-180.

Sintering Iron Ores

Condensed from

"Journal of the West Scotland Iron & Steel Institute"

The present practice of sintering is to mix fine ore with fine coke and, after heating to a suitable temperature, to bring about sintering by drawing cold air through the preheated bed. By rapid combustion of coke particles, the temperature of the bed is raised around 2372 to 2732 F. It should be noted that it is the volume of air and not its pressure that is essential.

The other essential is the size of the coke particles. The smaller the coke particles the greater the surface exposed to the oxygen of the air. However, too fine coke particles, below 1/60th, will result in too little voidage. This voidage is bound up with suitable grading of the charge and with water additions.

Investigation into factors underlying sintering practice has been in progress. In order to have complete control of the process, a unit was constructed consisting of a platinum sintering vessel, nichrome wound furnace, steel support tube, meter, and a water manometer. The charge was heated to a predetermined temperature and then the furnace lifted clear of the sintering unit.

Experiments showed that resistance of the bed steadily increased with increase of fines. With less than about 70% of fines, addition of water over the range, 4 to 8% makes little difference to permeability of the bed, but with more than this amount of fines water becomes critical.

Taylor ZIRCON for ALUMINUM OPEN HEARTH FURNACE BOTTOMS

Section thru Taylor Zircon bricks enlarged to Twice Actual Size to emphasize the "weld-like" joint of Taylor Zircon #701 Cement.

Unretouched photograph

16,000,000 lbs. of aluminum foundry returns were melted on the Taylor Zircon hearth of which these bricks were a part. Specimen removed for examination — the original Taylor Zircon bottom and side wall is still in service.

Note the clean, tight, weld-like joint of Taylor Zircon No. 701 Cement and complete lack of metal or oxide penetration in either the Zircon Brick or the joint. This is characteristic and not an unusual example.

Properties of TAYLOR ZIRCON REFRACTORIES and other pertinent data are given in Bulletin No. 200. Write for your copy today.

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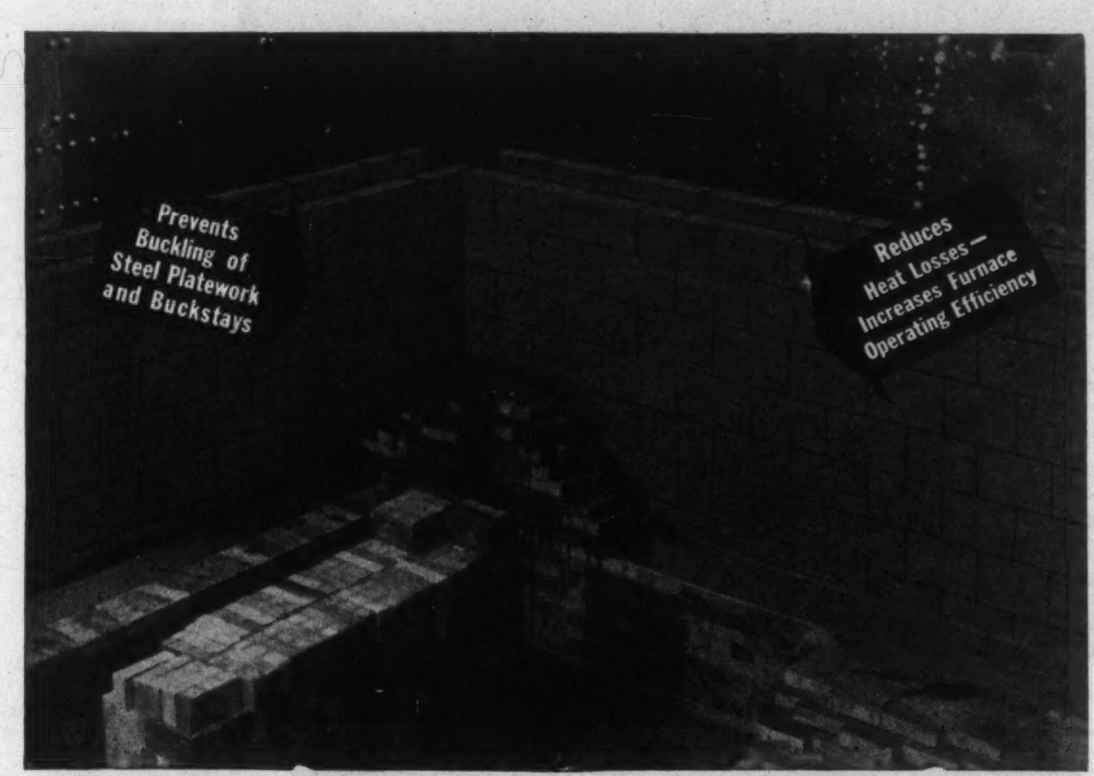
in Furnace Walls



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Coating — Seals and insulates all types of furnace walls. Highly plastic, works and spreads easily.

Blocks — Highly efficient insulation where larger size units may be required.

Concrete — Monolithic castable insulation with high insulating value.

Granules — Loose-fill, efficient insulation, weighs only 6 pounds per cubic foot.

Protects furnace steelwork and plating from excessive heat with a strong resilient cushion which absorbs expansion stresses.

KEEPS HEAT INSIDE FURNACE WALLS

Excellent insulation,— a 4½ inch thickness being equivalent in heat flow resistance to more than 29 inches of fire brick.

Find out how quickly THERM-O-FLAKE Brick will pay back their cost in reduced furnace heat losses. For specific data, indicate type of furnace and approx. operating temperatures in writing to:

Illinois
Clay Products
Company
JOLIET, ILLINOIS

Therm-O-flake BRICK

FOR HOT FACE TEMPERATURES UP TO 2000° F.

From a study of synthetic sinters it is noted that the quantity of carbon present in the original mixture is an important and critical factor, for not only does carbon supply the necessary heat to bring about sintering, but it also reduces some of the iron oxide in the ore to ferrous oxide, which readily combines with the silica to form fayalite (2 FeO • SiO_2), or if silica and lime are present, to form calcium iron olivines.

If no silica is present, but only CaO, then fusible ferrites melting around 2192 F. are found by interaction between CaO and Fe_2O_3.

Iron occurs chiefly in the form of magnetite in sinters. If thermal equilibrium were established, then the state of the iron would be determined by the temperature and CO/CO_2 ratio. However, it is not probable that equilibrium is established, and the outer part of sinter hematite can often be identified by the microscope.

Whether the whole of the iron goes into solution in the silicate, and then crystallizes as magnetite on cooling under oxidizing conditions, or whether the iron oxide transforms by a continuous process of solution and precipitation of the less soluble form, in this case magnesite is not clear from micro-examination of sinters. The skeletal nature of some of the crystals would suggest such to be the case, and also suggests the magnetite (white) is forming at the expense of the darker grey material, possibly ferrous oxide.

Particle Size Small

In order to get complete solution of the constituents in sintering and so permit the interpreting of their structures, it would be essential that the particle size of the ores be very small, ⅛ in. or less. If the solution is not complete then free lime might be present, resulting in slaking of the sinter if it gets wet or is stored.

A sinter may be stable for some time after manufacture, but might dust in time, due to the presence of calcium orthosilicate. Such sinter, even if it did not dust, would dust in the furnace.

During the course of the work, a study has been made of the changes made by iron oxide. Satisfactory sinters have been produced from pure ferric oxide made from iron oxalate. The iron oxide contained no silica, lime or other impurity. To this was added carbon in varying proportions, and the mixture heated to various temperatures, both in vacuo and in air.

By altering the amount of carbon and temperature, different structures were obtained. From examination of these structures, it would appear that ferrous oxide is formed as the first product that is in the liquid state. As the reaction proceeds, small cubes of magnesite separate out from this liquid phase, until all the iron is magnetite.

This type of change takes place when the reaction takes place in air or vacuo, with this difference, that in air more magnetite is produced under a given set of conditions. The structure so produced is porous, although not to the same degree as commercial sinter.

—R. Hay & J. McLeod, *J. West Scot. Iron & Steel Inst.*, Vol. 50, Pt. 6, pp. 55, 64.

. . . there are NOW
ALLOYING MATERIALS ENOUGH
for all needs

SHORTAGES of important metallurgical materials have now been either directly relieved or compensated by satisfactory alternatives.

item: TUNGSTEN. Except for a few quite special uses, restriction is off. New production, greater volume of imports, and resulting growth of stock piles have brought relief.

item: MOLYBDENUM. Crippling regulation is a thing of the past. Renewed availability of tungsten and other scarce materials, new Molybdenum production, and improved economy of alloying practice, have lessened the need of Government restriction.

item: BORON. The potency of Boron as an intensifier of the effects of other alloying materials, has been the subject of almost incredible revelations in recent months. Very minute additions can be substituted for considerable percentages of scarcer and more costly elements, with full maintenance of the hardenability and other essential properties of high-grade steels. In cast irons, the percentage of Boron addition runs higher but is still very low and the results are remarkable.

The problem of an economical and satisfactory form in which to introduce Boron is met by a special ferro-boron produced by the Molybdenum Corporation.
As to the availability or approved uses of Tungsten, Molybdenum, or Boron, correspondence is invited.

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Offices: Pittsburgh, New York, Chicago, Detroit, Los Angeles, San Francisco, Seattle.

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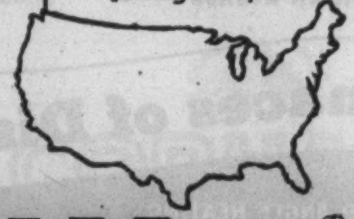

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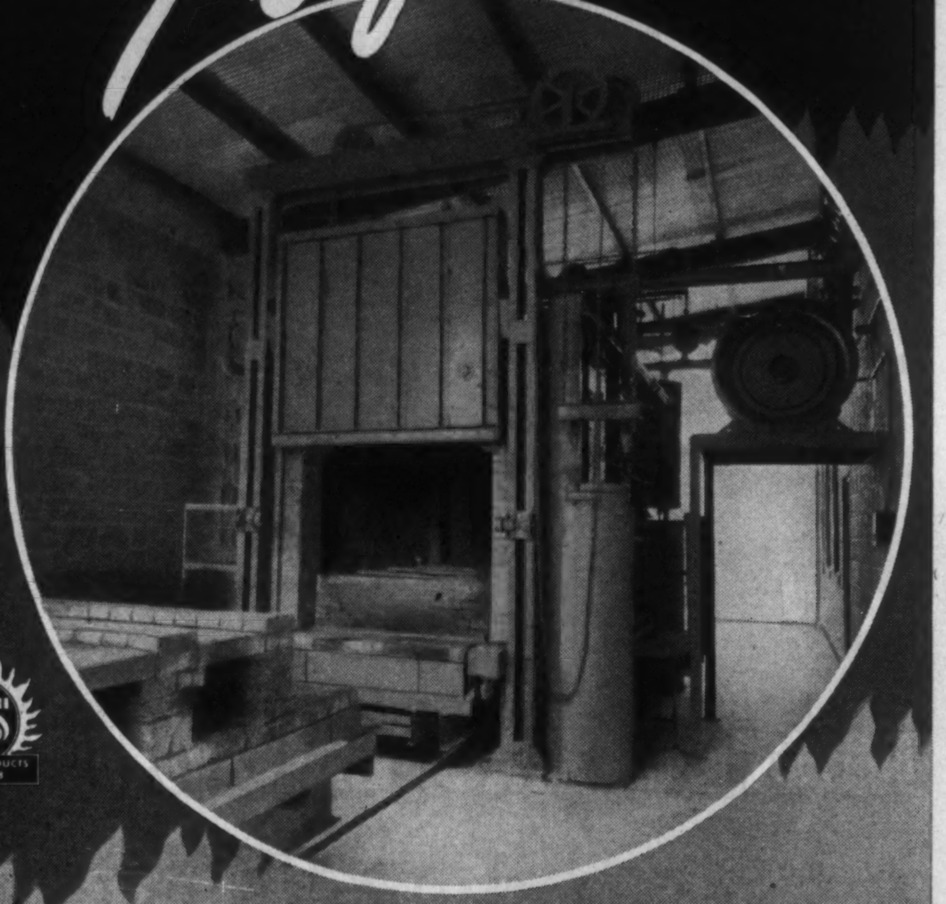

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The metallurgist and superintendent in the stainless steel foundry where this R-S Car Hearth Furnace was recently installed agree that "it is a fine piece of equipment and doing an exceptional job."

The uniformity and physical properties obtained are far superior to results previously secured. Gas-fired and equipped with two-zone temperature control, this furnace reflects the skill and painstaking care of R-S Engineers in adapting R-S equipment to a particular heat-treating problem.

Regardless of the scope or type of your heat-treating requirements, the door is always open for consultation with R-S Engineers. Heat-treating perfection is the watchword.

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Buy War Bonds

Rolling Light-Metal Sheets

Condensed from "Zeitschrift für Ver. deut. Ing."

Although the fundamental equations for the calculations of roll stands, magnitude and direction of forces are well known for the rolling of steel, they are not yet known in the same measure for the cold- or hot-rolling of light metals. In order to obtain this information, experiments are described with electrolytic lead; aluminum, 99.5%; LM1, Al-Cu-Mg alloy with 4.2 Cu, 0.73 Mg, 0.74 Mn, 0.52% Si; LM2, Al-Cu-Mg alloy with 3.94 Cu, 0.90 Mg, 0.45 Mn, 0.35% Si; LM3, Al-Mg alloy with 7.0 Mg, 0.4% Mn; ST1, nickel steel with 15 Ni, less than 0.2% C; ST2, aluminum steel with 5 Al, less than 0.2% C.

The mechanism of rolling and the determination of the levers of attack are explained, and the effect of the surface quality of the rolls (dry or greased) shown in curves; they show the advantage of smooth rolls for cold-rolling soft materials, and the economy of using oil in cold-rolling hard metals.

An increase in the cold-rolling velocity of from 0.4 to 2 m. per sec. (1.6 to 7.9 ft. per sec.) resulted — contrary to hot-rolling — in only a small increase of roll pressure and torque. The roll pressure was a straight line for a large range of diameters (185-360 mm. [4.7-9.2 in.] and above), so that points found for one curve can be interpolated and even extrapolated for other diameters.

Metallic materials show in cold-rolling, besides the plastic, an additional measurable elastic behavior.

The conditions are somewhat different in hot-rolling, as the effects of interior and exterior friction, which can be taken into account in cold rolling, cannot yet be separated in hot rolling. Therefore, curves are given for the metals mentioned, showing the deformation resistance as functions of the reduction.

—O. Emicke, *Z. Ver deut. Ing.*, Vol. 87, July 10, 1943.

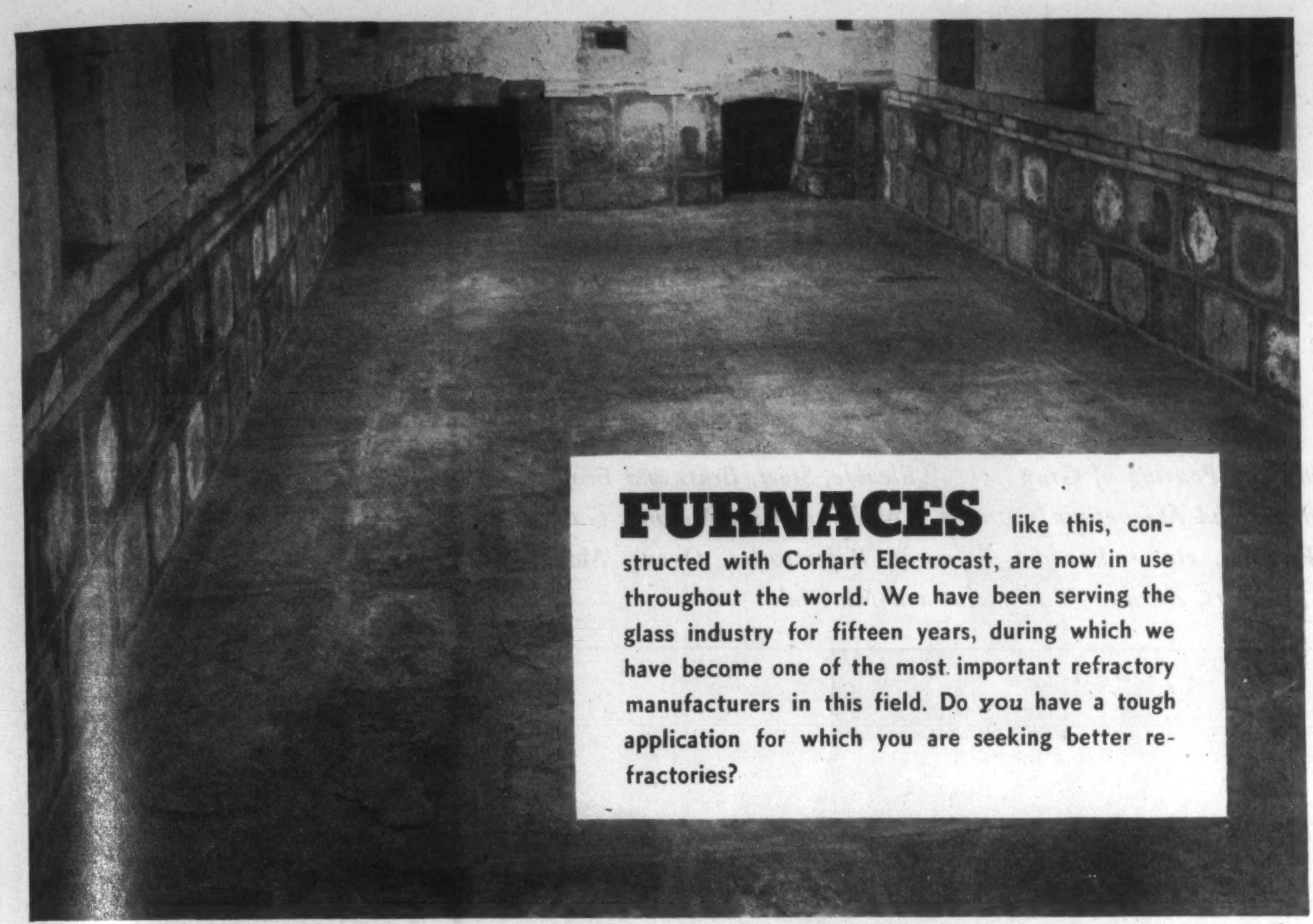
Standard Brick Arc Furnace

Condensed from "Stahl und Eisen"

Various factors influence unfavorably the life of an acid brick roof in a basic furnace. A "standard arch brick" was developed for use in an arch with embedded cooling rings, which at the same time serve as reinforcing elements in the arch. The life of the cooling rings was between 300 and 700 melts, and depended largely on the cleanliness of the cooling water. The consumption of bricks dropped to less than half after embedding cooling rings, going from an average of about 18 kg. of brick per ton iron to about 7 kg.

The cooling rings are arranged in such manner that the electrodes are free to some lateral movement. For furnaces of 5200-mm. (204 in.) diam., the roof is made 240-mm. (9.5 in.) thick, and the bricks are 300-mm. (11.8 in.) high.

—H. Muller, *Stahl u. Eisen*, Vol. 63, Mar. 18, 1943, pp. 217-224.



FURNACES like this, constructed with Corhart Electrocast, are now in use throughout the world. We have been serving the glass industry for fifteen years, during which we have become one of the most important refractory manufacturers in this field. Do you have a tough application for which you are seeking better refractories?

The entire flux walls and bottom of this 16' x 56' glass furnace are constructed of Corhart Electrocast blocks.

Now Still Another Corhart* Uninsulated Bottom!

HERE'S another item to add to your "mental file" on Corhart* Electrocast bottoms.

In March, 1942, a well-known glass manufacturer installed his first uninsulated Corhart Electrocast melting-end bottom. On the strength of its performance, this customer has now installed another uninsulated Corhart bottom in another of his tanks. Both are of 12" Corhart Standard Electrocast.

But these two tanks are by no means the only ones in which uninsulated Corhart bottoms are now being used.

In addition to numerous insulated bottoms, there are now at least THIRTY-EIGHT uninsulated Corhart bottom installations in glass tanks in North and South America. . . .

We knew you'd like to have these facts.

Corhart Refractories Company, Incorporated, Sixteenth & Lee Streets, Louisville, Kentucky.

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Foundry Practice

Ielting and Pouring of Gray Iron, Malleable, Steel, Brass and Bronze,
luminum and Magnesium Castings • Molding, Core-Making, Gating
nd Risering, etc. • Foundry Furnaces, Refractories, Ovens, Molds,
ands, Binders, Auxiliary Equipment and Materials

CONTENTS

Light Metal Foundry Control 644
Casting Magnesium 644
High Strength Cast Irons 646

Light Metal Foundry Control

Condensed from "American Foundryman"

The rapid expansion of foundries producing materials of war has necessitated the hiring of thousands of inexperienced men, resulting in a heavy burden on supervising foundrymen. With the present increase in production and the labor turnover, it is sometimes necessary to promote men to positions for which they have been trained very hastily. This is especially true of foundries manufacturing aluminum and magnesium castings.

This article describes a practice now in operation that has proved satisfactory as a means of increasing production through the training of men, control of processes, and reduction of scrap losses. Although it is in existence in a light metal foundry, it can be applied directly to any foundry.

Foundry metallurgy control, as the system is called, is directed by the metallurgical department, which reports to the foundry management. Good control is the adherence to a satisfactorily established procedure. Starting with incoming raw materials and ending with the finished casting, the following are phases of foundry practice that require class control.

(1) Proper sampling, analyses and testing of incoming sand, sand additions and metals; (2) identification of materials in storage; (3) preparation of sand; (4) testing of molds and cores; (5) melting and pouring practice.

(6) Handling of scrap metal; (7) heat treatment; (8) routine temperature checking of furnaces, ovens and pyrometers; (9) chemical treatment baths; and (10) chemical and physical testing.

There are standard sampling procedures, and these should be followed to the letter. Although sand and metal can be purchased to specification, it is good practice to test them thoroughly before use. After the metal and sand are tested and approved, they should be stored, properly identified, and placed in the hands of the sand or metal control man.

Sand Control

Control plays a vital part in the preparation of the sand. For example, in a foundry when heaps of molding sand are located near each group of molders and are reconditioned for reuse on the spot, sand control plays an important part.

Sand testing of prepared molding and core sand should be conducted to keep a constant check on the properties of the sand and cores. This is especially true in reclamation systems.

In magnesium foundries, a periodic check on the inhibitor content of the sand is necessary. Should a large casting burn because of too little inhibitor in the sand, the loss is far greater than the cost of a simple test of the sand.

Good melting and pouring practice is so necessary that it has been found advisable to place an observer at each pouring station. Proper segregation of foundry and machine shop scrap must be accomplished in order to avoid contamination on remelting. However, care must be exercised that chills, core wires, sand and other impurities are not charged in the remelt furnace.

Another of the phases of foundry control is the periodic check of temperature recording instruments on furnaces, core ovens, and at melting stations. Control of the composition of atmosphere in direct oil-fired melting furnaces will give increased pot life and reduce lost time in maintenance.

Chemical and physical testing of chemical coupons and tensile test bars, representing the various melts and heats, is the last and most important part of foundry control. Physical tests should be standardized to the smallest detail. All samples for test should be obtained by a foundry control man and marked immediately to prevent loss of identity.

There may be some question as to whether or not the benefits of foundry control would warrant the expense. A record kept over six months has shown a steady reduction in scrap loss, an improvement in the properties of the castings, and increased production efficiency.

—R. E. Ward, *Am. Foundryman,* Vol. 5, Dec. 1943, pp. 2-5.

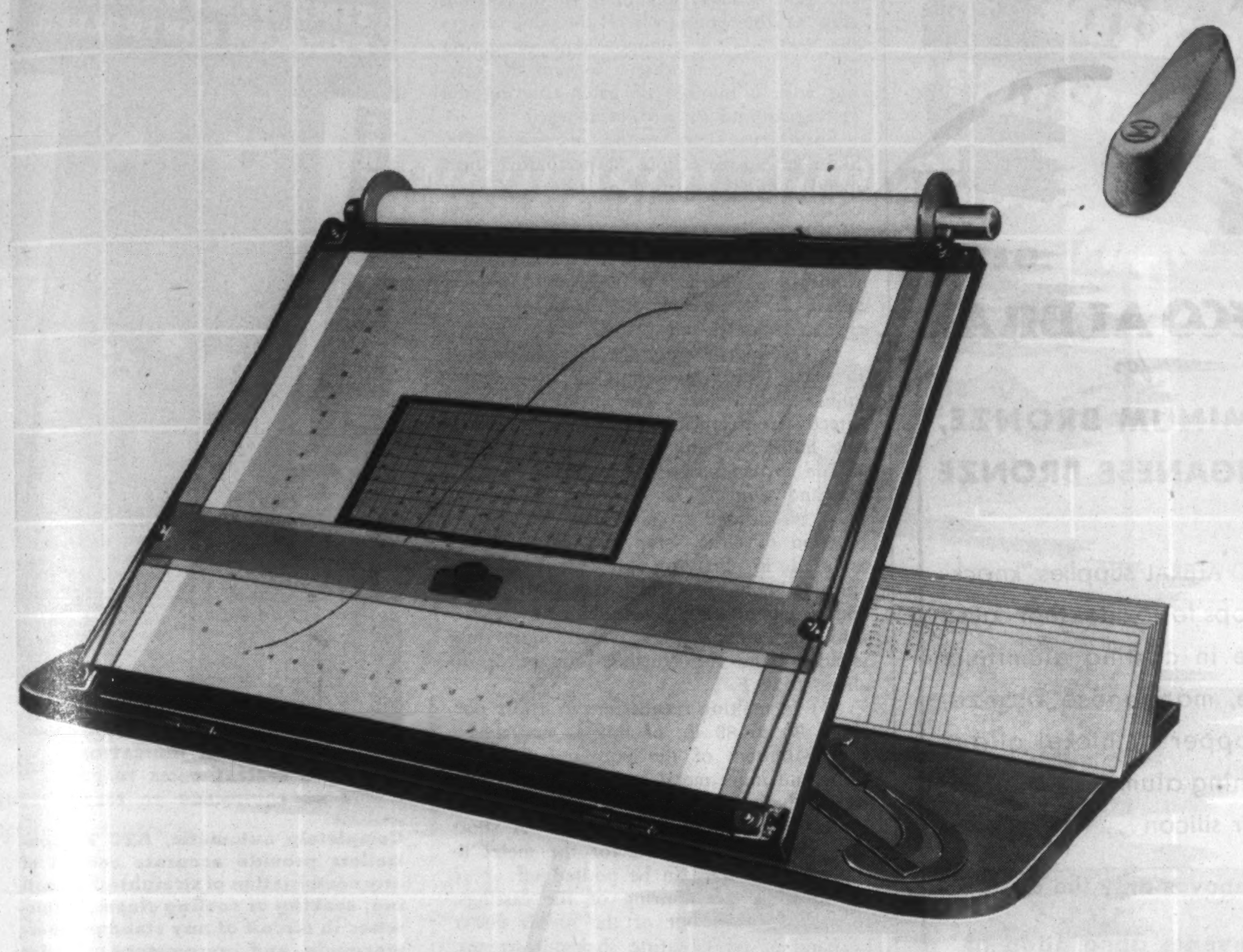
Casting Magnesium

Condensed from "The Foundry"

The tremendous demand for magnesium castings, principally in aircraft work, has created a need for information regarding the layout, equipping and operating of magnesium foundries. The quantity of finished castings that can be manufactured per month varies from 3 to 8 lb. per sq. ft. of floor space.

Sand for magnesium castings must have high permeability, 25 to 45, as magnesium alloys are so light that sand must be open enough to prevent back pressure.

On heavy castings that cannot be treated with risers, chills are used to equalize freezing of heavy and light sections. Chills may be cast iron or bronze. Adequate space must be allowed for bench and machine molding. Provision should be made for side floor molding.



How We Keep Perfect Control of Ingot Specifications

The curve chart above, calculates the exact quantity of every element in a Michigan Smelting non-ferrous alloy. It is plotted from data supplied by a Spectrogram as read on the Densitometer in our laboratories. This quantitative analysis is made from a sample drawn from the furnace charge, taken while the metal is still molten—speeded to the Spectrograph where the spectral lines are photographed. Thus, before a single ingot is poured, we can determine and make certain, that the alloy in question meets every specification requirement—is made exactly as ordered.

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And not only does ALBRAL "knock out" the cause of porosity, brittleness, low strength, and dirty skin without interfering with the aluminum, manganese, or silicon content—but it *improves* the physical properties of the alloy and permits you to use even 100% scrap safely.

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Gates should be located at sections of uniform casting thickness, and the area of the gate should be similar to the casting area at the point where the gate enters the casting. A common type of gating is to have a ring runner around the casting with a number of gates entering the casting around its circumference.

Sprues used are round or rectangular. Skim gates are sections of perforated sheet metal, which are used as filters to keep oxide skims out and break up the flow of metal. Skim gates are inserted at the bottom of the sprue or in horizontal runners. Whether rectangular or round sprues are used, they should be of a size that can be choked easily.

In crucible melting, the metal is melted in welded steel pots holding from 60 to 200 lb. of metal. The metal is poured directly from crucibles. The flux pot usually holds 500 lb. of magnesium.

The correct procedure for crucible melting and pouring is: (1) All iron scale must be cleaned from furnaces. A combination of clean scrap and virgin ingots is used in charging pots. A flux is sprinkled on the metal during melting, and at about 1300 F. the flux is stirred into the metal, after which more flux is added and the crucible brought up to about 1650 F.

(2) In melting magnesium in a flux pot, about 70 to 80 lb. of flux is first added to the bottom of the pot, and then the risers and ingot metal are added. The flux should be constantly added, and at 1300 F. the metal should be stirred. A short time should be allowed for the metal to cool, and then it can be poured off.

Following the pouring of the castings, they are shaken out of the molds either by hand or on vibrating shakeout screens. Cores are shaken out of the castings in a similar fashion. After grinding, the castings are burred. Surplus metal, fins, etc., which are inaccessible to grinding wheels, are removed with rotary files.

Castings should be thoroughly cleaned before plating. Prior to plating, they are pickled for about 30 sec. to 2 min., depending on the size of the casting. Final inspection should search for defects such as shrinks, cracks and other items of smaller nature.

—F. A. Foxall, *Foundry*, Vol. 71, Nov. 1943, pp. 110-111, 166-168; Dec., pp. 110-111, 188-194.

High Strength Cast Irons

Condensed from "Foundry Trade Journal"

The program of this research was designed to investigate the influence of the alloys, nickel, copper, nickel-chromium, copper-chromium, molybdenum, nickel-molybdenum, and copper-molybdenum to a range of cast irons chosen from the material presented as part of the first report. This material covered ranges of composition from 1.5 to 3.5 C, and 1.0 to 2.5% Si, with various quantities of Mn and P.

The desirability of paying some attention to irons of cold-blast origin was brought out in the discussion on the Committee's first report, and in order to examine this type of material, some experiments were carried out using cold-blast as well as the normal hot-blast material.

TIME-TEMPERATURE
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CONTROL
Heat Rate
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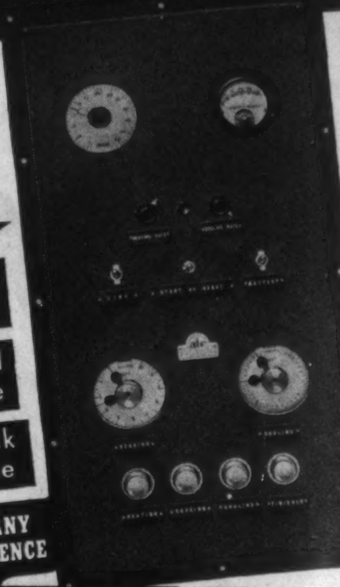
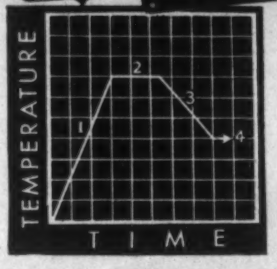
Soak Time
IN ANY SEQUENCE





STRESS—RELIEF PROGRAM: Heat-rate 1 adjustable to 175° F/hr. for 48 hr. max., automatically going into timed soak 2, adjustable to 10 hr. max.; cool-rate 3 follows automatically, adjustable to 175° F/hr. for 60 hr. max.; final temperature 4 maintained until manually ended.

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★ NO SPECIAL CAMS TO CUT
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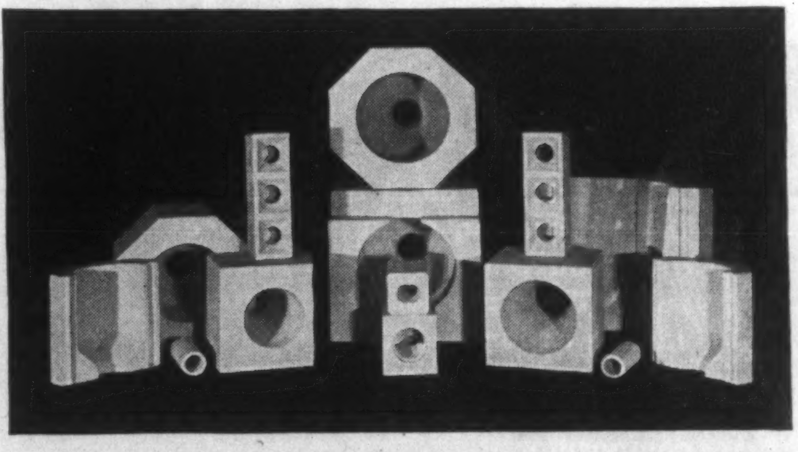

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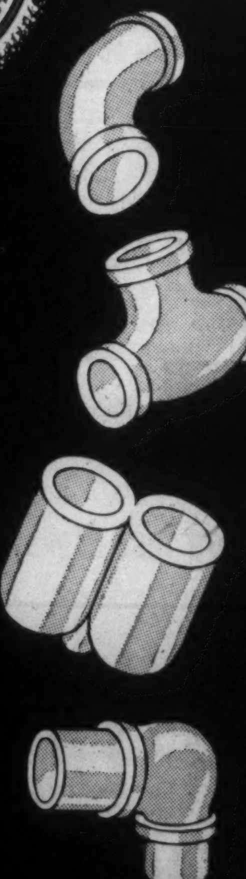


DETROIT ELECTRIC FURNACE DIVISION
KUHLMAN ELECTRIC COMPANY • BAY CITY, MICHIGAN

Some inoculation experiments were also carried out, using calcium silicide and silicon metal as inoculating agents. These tests were made both with and without adjustment of composition by silicon reduction to allow for the quantity added in the inoculant.

Comparison of cold-blast irons with hot-blast irons showed no difference by the properties of chill, shrinkage, hardness and elastic modulus. The cold-blast irons had a tensile strength about 5% greater, a transverse strength about 6% greater, and a transverse deflection about 11% greater than the hot-blast irons tested.

This difference in transverse deflection was made up mainly by the plastic portion of the deflection, which is 33% greater in the cold-blast irons, the elastic portion of the deflection being only 4.5% greater. The impact value of the cold-blast irons is also 11% greater than that of the hot-blast irons.

Effect of Elements

In reducing silicon to balance the graphitizing action of nickel and copper, it was found necessary to decrease silicon by about 1/6 of the amount of alloy added. It is usually taken that ⅓ of silicon has an equivalent graphitizing action, but it was evident from these experiments that this was not the case when silicon of the base alloy is initially low.

Nickel increases tensile and transverse strengths, elastic modulus and Brinell hardness; it reduces porosity, impact value and transverse deflection. Copper increases hardness, tensile strength, transverse strength and elastic modulus; it reduces deflection, impact value, and porosity.

Nickel plus copper increases hardness, transverse and tensile strengths, and elastic modulus; it decreases deflection, impact value and shrinkage. Nickel-chromium and copper-chromium increase hardness, tensile and transverse strengths, and porosity and, in the first additions, increase deflection and impact value; they have no influence on elastic modulus.

Molybdenum increases markedly the transverse and tensile strengths, the Brinell hardness, and the chill. The impact value is increased, and the shrinkage and total deflection also increases a little. Nickel-molybdenum and copper-molybdenum additions increase markedly the tensile strength, transverse strength, hardness and impact value.

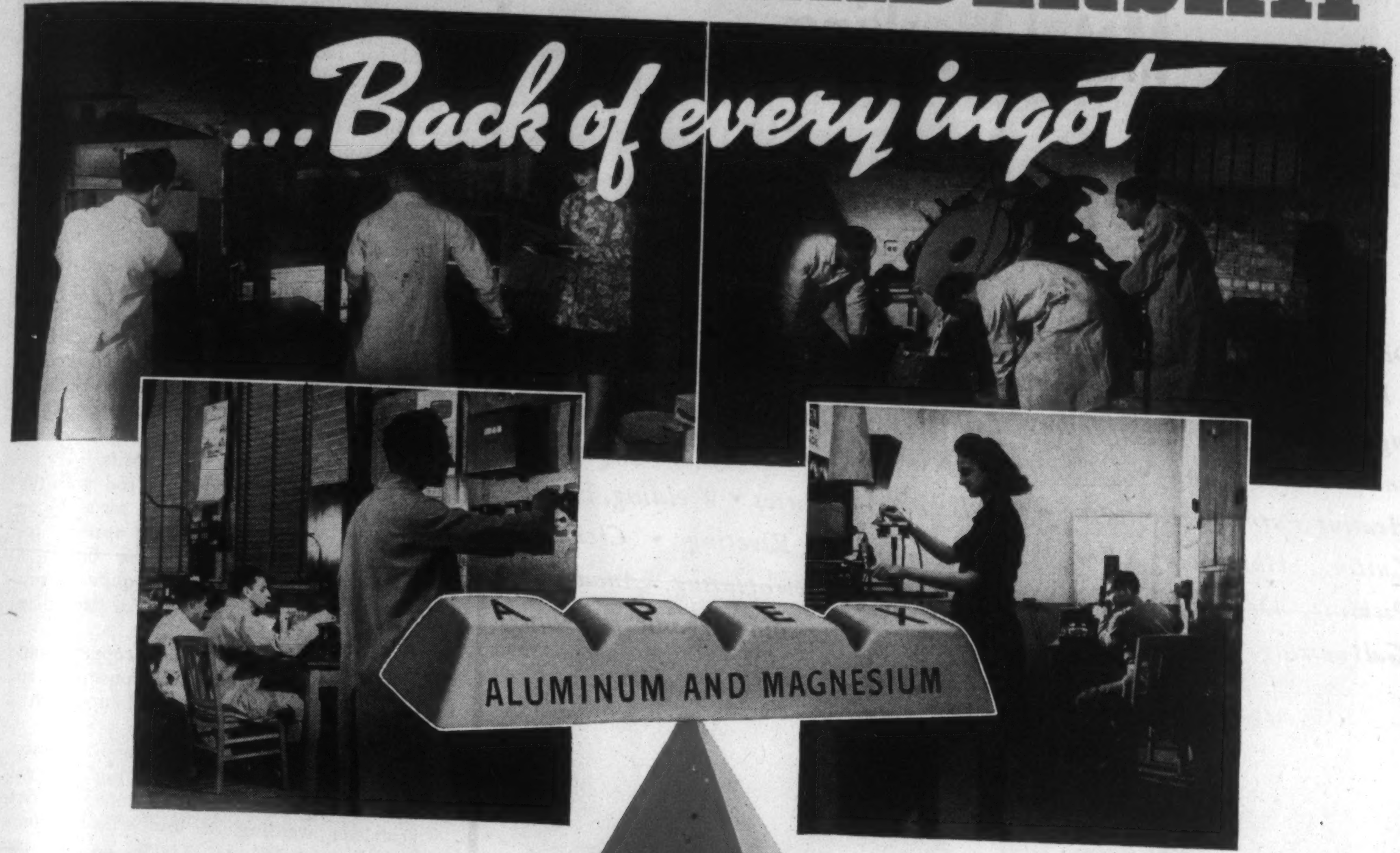
In both series, the elastic modulus is slightly raised, the shrinkage is a little increased, and the total deflection is raised by the first addition and then lowered to about its original value by the second addition.

There appears little advantage to be gained at the present time in pursuing the production of cast irons below 2.5% C. Their relatively high melting points, diminished fluidity, range of temperature over which they can be cast successfully, and their liability to porosity and shrinkage make the production of sound castings very difficult.

A plain iron containing 2.7% C and 2.0% Si can be improved by a ladle addition of calcium silicide.

—*Foundry Trade J.*, Vol. 71, Oct. 28, 1943, pp. 159-162, 158.

RESEARCH LEADERSHIP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Welding Copper Alloys

Condensed from "The Welding Engineer"

This deals with the welding (fusion) of copper and its alloys, and not with brazing It must not be confused with so-called "bronze welding," which is actually brazing. In this article the welding of bronzes with bronze welding rods will be dealt with. Thin gage metal cannot be properly welded with the carbon arc because of burning through, oxyacetylene being preferable.

In carbon arc welding, tack welding should be done every 6 to 8 in. to minimize the movement of the base metal. With oxyacetylene, proper allowance must be made in the set-up of the welding joint for the expansion of metal. In carbon arc welding, it is permissible for the operator to stop welding at any time, but not advisable with oxyacetylene.

Tough pitch copper, with a small percentage of oxygen as copper-cuprous oxide eutectic, should not be welded with oxyacetylene, since accumulations of the oxide will appear in the grain boundaries. Thinner gage copper can be welded more successfully. Carbon arc welding of tough pitch copper heavier than 1/16 in. has shown no tendency toward this oxide segregation. Phosphor bronze type welding rods are recommended.

The low-tin phosphor bronze should be used for fabrication if any cold working is to be done after welding. Silicon-bronze rod should not be used for the welding of tough pitch copper. The use of deoxidized copper for welding eliminates faulty results, as no copper-cuprous oxide eutectic occurs therein.

Deoxidized Copper Rods

Phosphorus deoxidized copper and silver-bearing deoxidized copper welding rods give dense deposited weld metal with tensile values of 25,000 p.s.i., though high fluidity of the weld metal is an objection. The use of silicon-copper rod containing 0.15 to 0.30% Si will produce exceptional tensile strength, ease of welding in all positions and soundness of deposits.

For carbon arc welding, a rod with 3% Si is superior, but the weld metal is not extremely fluid, and welding speeds must be slower. Phosphor-bronze Grade D welding rod has been used quite successfully for carbon arc welding of deoxidized copper.

All carbon arc welding of copper should be done in a downhand position, and the joint should be backed up with a copper chill bar or strip.

For handling the high copper brasses, a welding rod containing a high percentage of copper has been developed for oxyacetylene welding, a low silicon bronze containing 1.5% Si, 1.00% Zn, the rest copper. Its handling property under the torch is very satisfactory, since the weld metal is not so fluid, which property increases the tendency to braze.

Carbon arc welding of red brass is recommended, particularly when the welding can be done in a downhand position. The best rod contains 97% Cu and 3% Si. A high tin phosphor-bronze rod could be used, but inability to cold work the joint would handicap it.

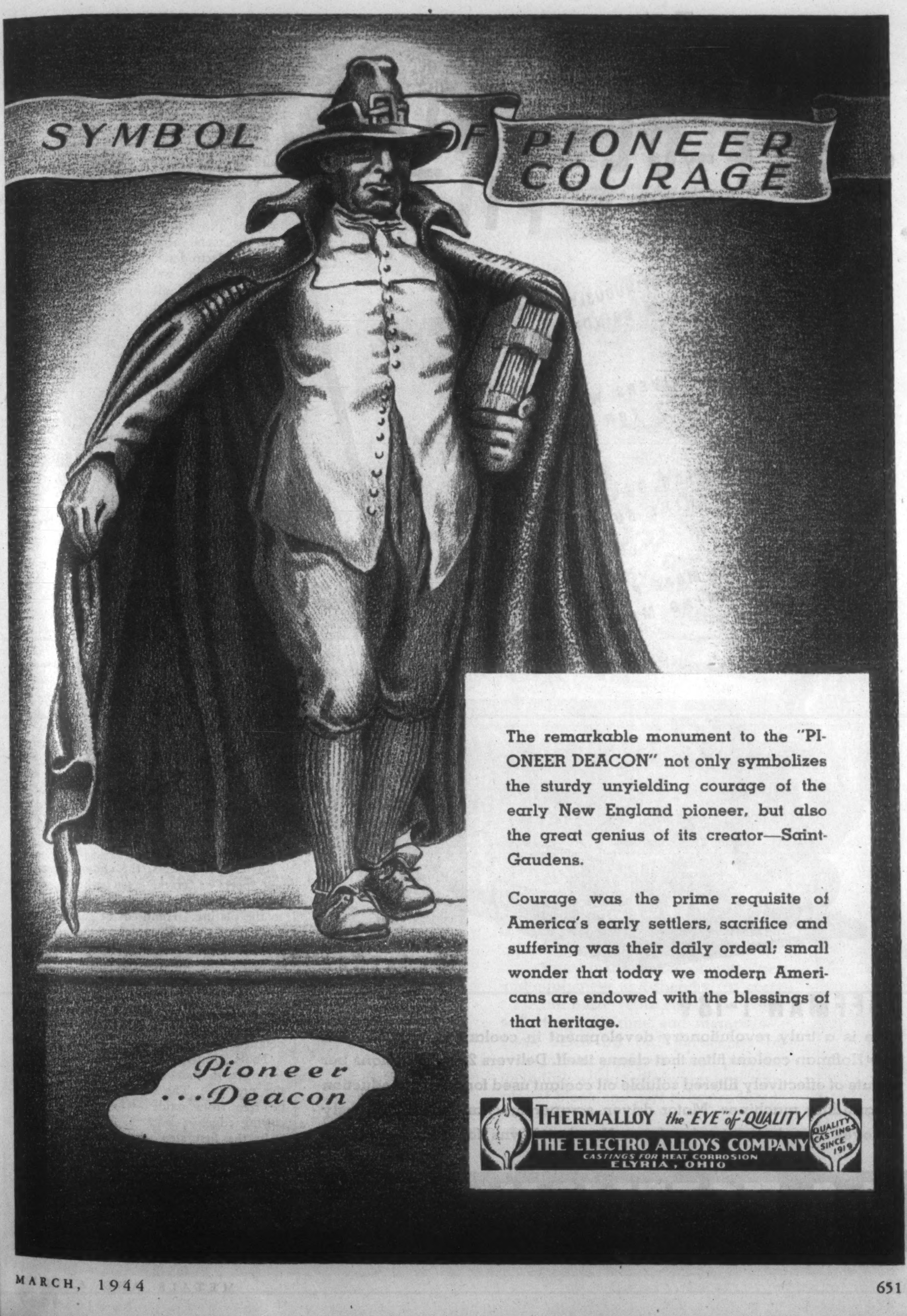
Welding High Zinc Brasses

The welding of high zinc brasses with copper contents of 58 to 80%, is about the same as for Muntz metal and naval brass. The latter two are used commercially where welding fabrication can be successfully employed. These alloys have been extensively brazed, using silver alloy and phos-copper types of brazing materials, and oxyacetylene welded, using the popular yellow brass brazing rods.

In the "oxy" welding of these alloys using yellow brass rods, care must be taken to obtain actual fusion of the side walls of the base metal.

The carbon arc welding of Muntz metal and naval brass is a recent development, used in the fabrication of distilling units and large diameter piping. The rod can be either low fuming bronze or high silicon bronze, the latter taking preference because of greater ease of handling and greater ductility resulting.

Preheating of the base metal is essential to get proper fusion and soundly deposited weld metal. All gages thicker than ⅛ in. should be beveled to a 45° angle. Mul-



The remarkable monument to the "PIONEER DEACON" not only symbolizes the sturdy unyielding courage of the early New England pioneer, but also the great genius of its creator—Saint-Gaudens.

Courage was the prime requisite of America's early settlers, sacrifice and suffering was their daily ordeal; small wonder that today we modern Americans are endowed with the blessings of that heritage.

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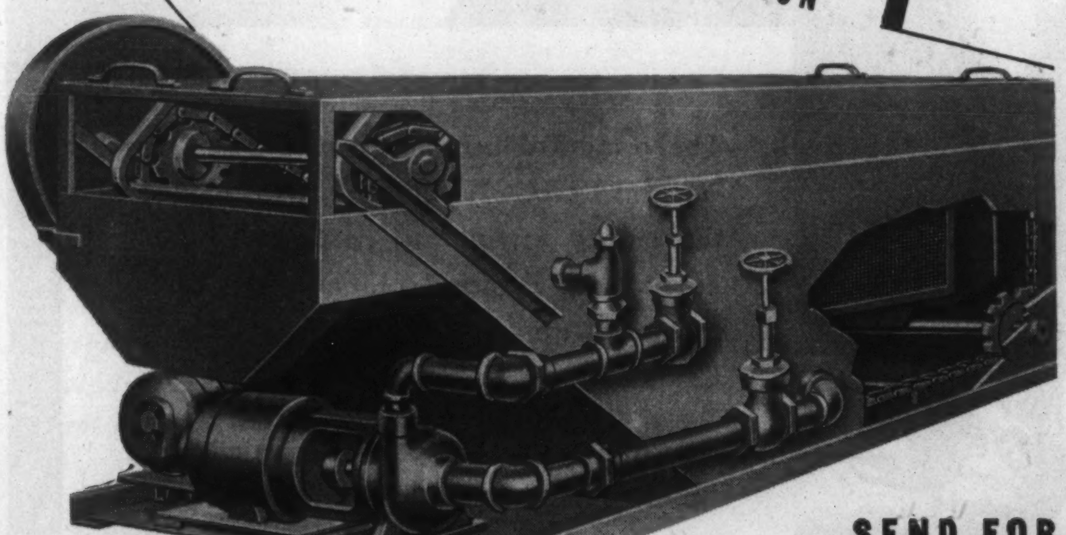

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tiple bead welding is recommended for 3/16 in. and heavier.

Phosphor bronzes can be satisfactorily welded by either the metal arc or carbon arc methods. A coated phosphor-bronze rod for metal arc welding is recommended; for carbon arc, the high silicon bronze rod is better.

Aluminum and beryllium bronzes are difficult to weld by either "oxy" or carbon. Satisfactory results with the carbon arc can be had if a high silicon bronze rod is used. Aluminum and beryllium copper alloys are also being welded well by the metal arc with coated aluminum-bronze electrodes.

Carbon arc welding should be given preference for all bronzes except those of aluminum and beryllium, for which the metal arc is better.

—J. J. Vreeland. *Welding Eng.*, Vol. 38, Nov. 1943, pp. 42-45; Dec. 1943, pp. 56-58.

Chromium Plating of Tools

Condensed from "Mill and Factory"

Chromium plating has always been considered a very difficult art. The process outlined below eliminates most of the difficulties.

Most chromium plating was done on copper because it was not practical to apply chromium direct to steel, especially if there was a possibility of pressure being applied to the chromium-plated surface. Under such conditions the chromium would peel and crack. This was one of the main reasons why chromium plating was not used to any extent on perishable tools, gears, cams, etc.

A short while ago, many of the earlier shortcomings of chromium plating were overcome by means of the Lundbye process. It was proven that chromium could be applied direct on to steel, and by an oil after-treatment, the chromium would be made an integral part of the underlying material.

After this process, the chromium would not peel or crack, even when pressure up to 200,000 p.s.i. variable was applied to the plating. Hundreds of concerns have found that it increased their tool life from 50 to 5000%, depending on the type of tools and the material being cut.

The installation used is a simple homemade outfit. It cost less than $50, and thousands of small tools have been plated successfully in it. [The author gives a detailed description of it.]

Tools prepared for this process are the same as if they are to be used without the process. The surface must, however, be free from oxide — no scale on the cutting edge.

In the first step, the tool is placed in the steel cleaning tank as the anode at 3 to 4 amp. per sq. in. in a 10% sodium or potassium hydroxide solution at room temperature for 30 sec. It is then rinsed in water, dipped in a 10% hydrochloric acid solution for a few seconds, and again rinsed in water.

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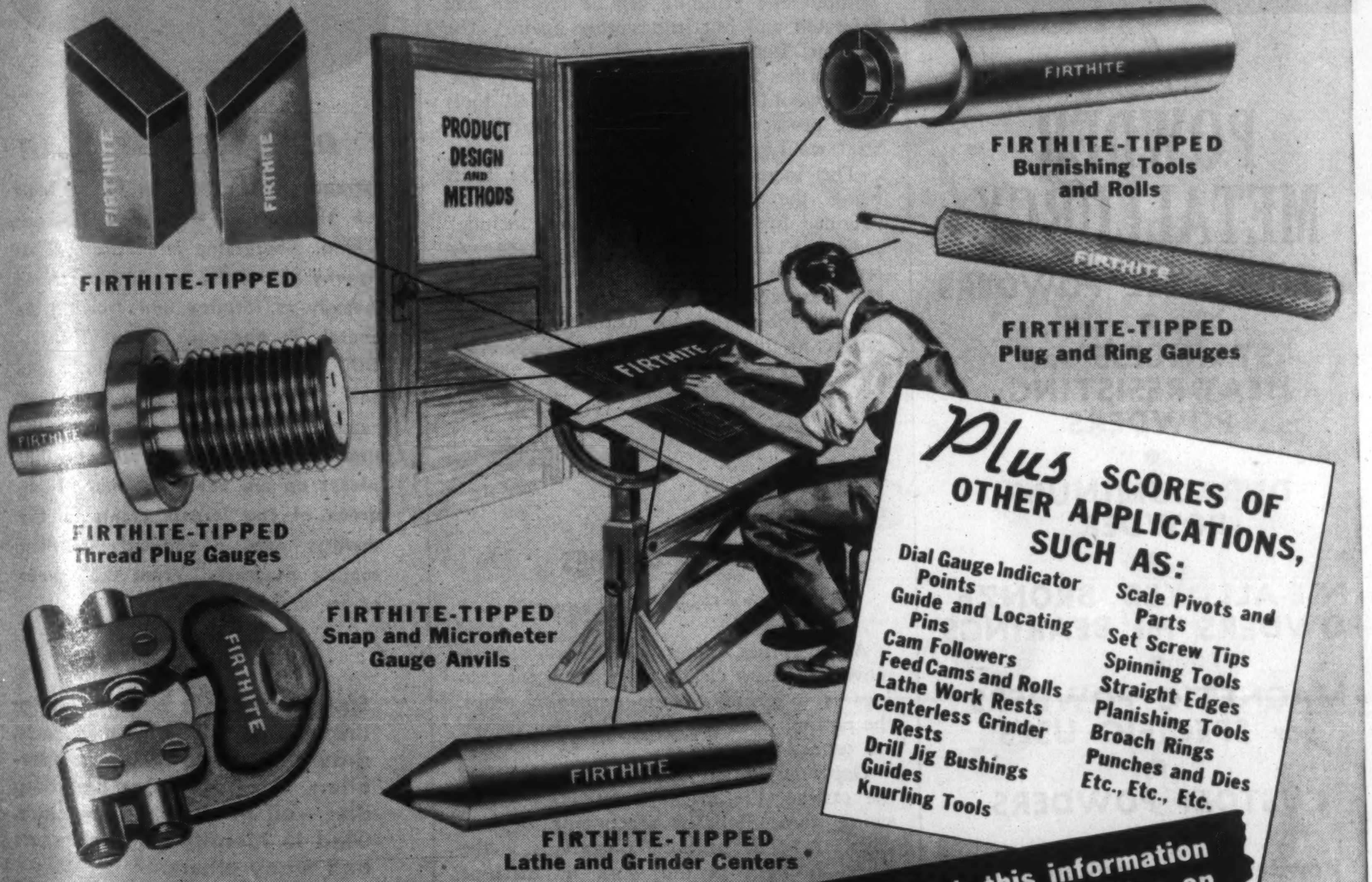

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The tool is then fastened to the cathode bar in the plating tank, and the current is reversed for a few seconds. The tool is then plated from ½ to 2 min., depending upon the steel and the thickness of plate required. The tool is removed from the plating tank, rinsed, dried and submerged in a hot oil bath at 350 F. for about 1 hr. in a steel tank. The tool is then ready to give 50 to 5000% longer life than before the process was applied to it.

Many tools when plated with this process, after 3, 4 or 5 times their normal unplated life, can then be stripped of the remainder of the chromium, and without any grinding can be replated and retreated and put into service again. The average increase in tool life with this process has been somewhere around 400%. This would mean that, if all small tools were processed, our supply of critical tool steel would go four times as far.

The increase in tool life is far from being the only advantage that can be obtained by this process. Others include: reduction in friction, lower horsepower requirements, cleaner cutting, higher speed and less scrap.

The process is made available by application to the Crowell-Collier Publishing Co., 250 Park Ave., New York 17, N. Y.
—A. Lundbye, *Mill & Factory,* Vol. 33, Dec. 1943, pp. 103-104.

Snagging Castings

Condensed from "The Foundry"

After sprues, gates and risers are removed, the next cleaning operation for castings is to grind off the remaining stubs, the parting lines and fins. These operations are termed snagging.

Depending upon the size and design of the casting, the machines used are either swing frame, floor or bench type, or portable. In none of these operations is the wheel brought to the work by machine movement; all operations are done by hand.

Swing frame machines are used for grinding castings that are too large to be moved against the wheel by hand or hoist. Swing frame machines consist of a horizontal frame with a motor on the rear end, which drives the wheel on the front end through gears or belts.

Wheels commonly used on swing frame machines are of 16, 18, 20, or 24 in. diam. The better machines have two or more speeds, so that as the diameter of the wheel is reduced, the speed in surface ft. per min. can be maintained by stepping up the revolutions per min.

Floor and bench stand grinders each have a grinding wheel spindle, either direct or belt driven, generally mounting a wheel at each end. These machines are used for production snagging of light- and medium-weight castings.

Portable snagging grinders are used to grind surfaces in inaccessible places, to remove stock at widely separated points and to blend curved surfaces. The machines are used with straight or cone-shaped wheels.

The principal use of cone-shaped wheels is for smoothing inside surfaces. Desk and

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IN THE WAR

Strenes today is being used for draw pots, draw pot inserts, draw rings for draw bench operation, for progressing upsetting dies—all in shell manufacture. Glad to identify all such users and many others.

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The assemblies are loaded on a conveyor at charging end of the furnace as shown below

... and carried through the furnace and discharged—securely joined—clean and bright

Miscellaneous assemblies are joined 60 to 75% faster, at ¼ the former labor cost by the brazing process.

"Greatly improved results—neater, stronger joints—60 to 75% faster, at about one quarter the former labor cost," that briefly is the report received from the production manager of a prominent plant after installing an EF continuous brazing furnace for joining some of their steel assemblies.

Within a month after installing their first brazing furnace, a second similar but larger furnace was ordered for joining other products—both furnaces are now operating side by side, joining all kinds of assemblies—large and small—neatly, economically and securely.

Products difficult or expensive to make in one piece can be made in several pieces and joined—thus not only reducing the cost but actually improving the quality and appearance. Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly and economically joined right in the production line in your shop. Strong, leak-proof joints are made and the completed unit is discharged from the furnace—clean and bright.

Any number of joints in the same product or any number of pieces can be joined at one time. The most intricate parts or assemblies are made to actually "grow together" and joints made which are as strong, or even stronger than the original parts.

Investigate the brazing process for joining your ferrous and non-ferrous products. With slight changes in design you may be able to join your assemblies, neater, cheaper and stronger by this method.

Result of a laboratory test on an automobile fan pulley in which the hub was brazed to the web. The complete pulley was placed in a press and pressure applied. The steel web broke but the brazed joint held securely.

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cylinder wheel grinders are used for precision grinding.

Many foundries use special machines for the production of a certain type of casting, such as the interior of cast pipe. The machine mounts a wheel on a long spindle, and is usually suspended from a movable jib.

Snagging of stove tops is accomplished by feeding them under a series of grinding wheels, which have a transverse motion. Finer wheels do the finishing, and final polish is produced with polishing wheels impregnated with glue and abrasive.

It is essential that working pressure be balanced in relation to the grade of the wheel. Increased pressure will increase the rate of material removal, while decreased pressure will give greater wheel economy.

No matter which type of machine is used, vitrified bond wheels should never be operated higher than 6500 surface ft. per min. Hard organic bond wheels may be operated up to 9500 surface ft. per min.

To get the highest possible production at lowest cost requires the use of the right wheel for the job. But where a variety of castings must be ground, general purpose wheels must be used, many of which will not be ideal. Therefore, the best all-around compromise wheel must be chosen.

For snagging carbon, alloy, high-speed and stainless steels, annealed and malleable iron, and tough bronzes, the best abrasive is aluminum oxide. For gray, annealed malleable, brass, bronze and aluminum and its alloys, silicon carbide is used.

Most snagging wheels are resinoid or rubber bonded. They give a low over-all cost in spite of a higher selling price, since they can be operated as high as 9500 surface ft. per min.

Wheel and work should be brought together carefully, easily and smoothly, otherwise the wheel will become out-of-round, or broken by the sudden impact.

Malleable castings should be snagged in the hard, that is, before annealing, since snagging may generate enough heat to cause an annealed casting to go back to hard, or at least cause hard spots.

—G. S. Eisaman. *Foundry*, Vol. 71, Nov. 1943, pp. 119-120, 173-176

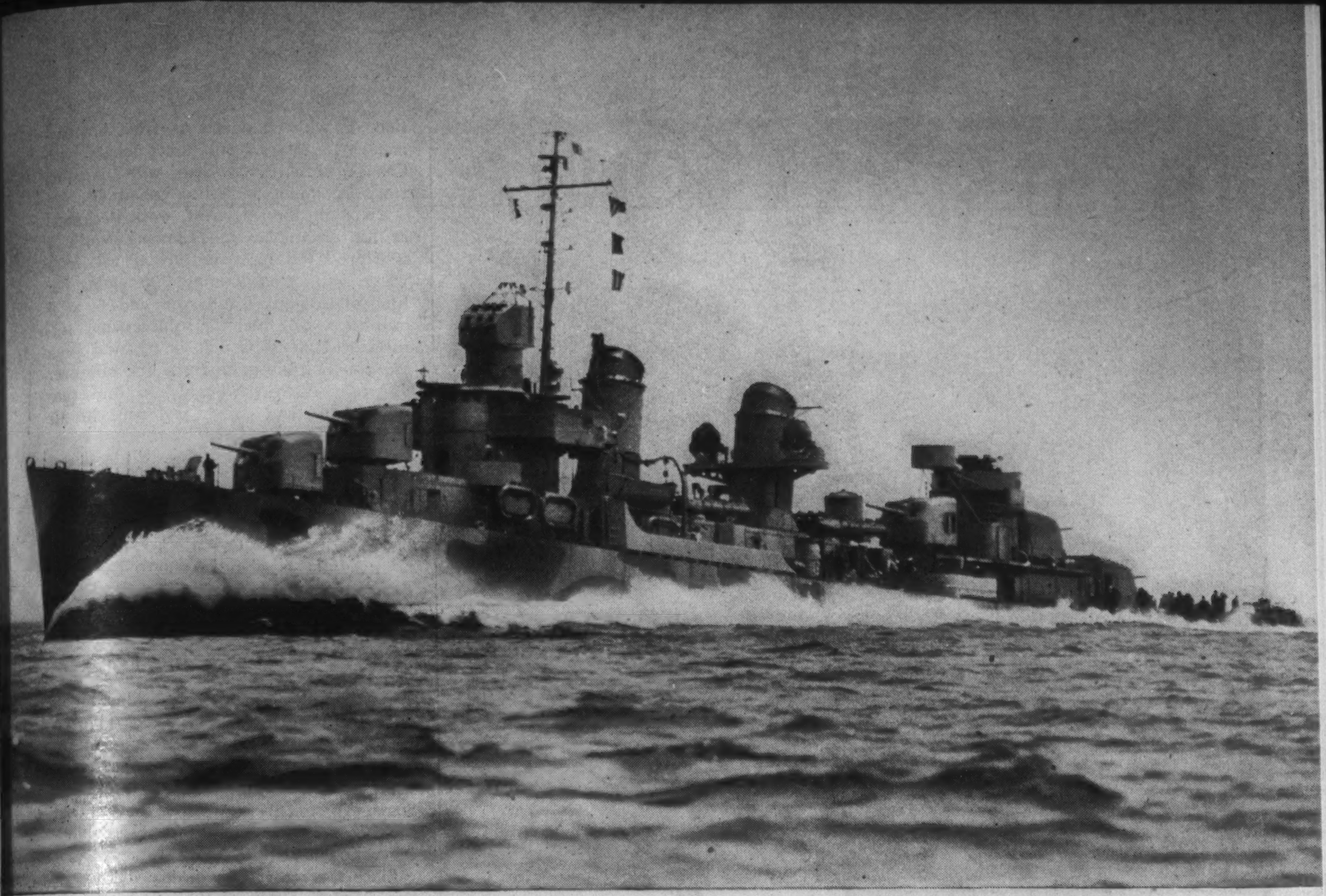
Protection for Zinc

Condensed from "Proceedings," American Electroplaters' Society

The Cronak process is a means of producing on zinc a film of chromium salts that inhibits the corrosion of the zinc during contact with water. In normal outdoor exposure, where mist, dewfall or rainfall dry quickly, the Cronak film has little or no value, *i.e.* it does not extend the period for which a given thickness of zinc will protect steel.

When zinc is in contact with stagnant water, or with water films that dry slowly, bulky films of white corrosion products form that may be objectionable in some applications, *e.g.* on internal moving parts.

The Cronak film minimizes this type of corrosion. The time required for forma-



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"A word of praise for the grand job the Bath Iron Works did on the ship. She has been through h—l and high water and never failed us. Keep on building ships as fine as this . . . We have put on nearly one hundred and fifty thousand miles and she is as good as new."

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Galvanized work on these ships is first cleaned with a Pennsalt Cleaner to insure a finish which will withstand the extreme corrosive conditions of the sea.

Paint stripping is another important use of Pennsalt Cleaners at the B.I.W. In fact there is a Pennsalt Cleaner scientifically designed for nearly every type of metal and maintenance cleaning.

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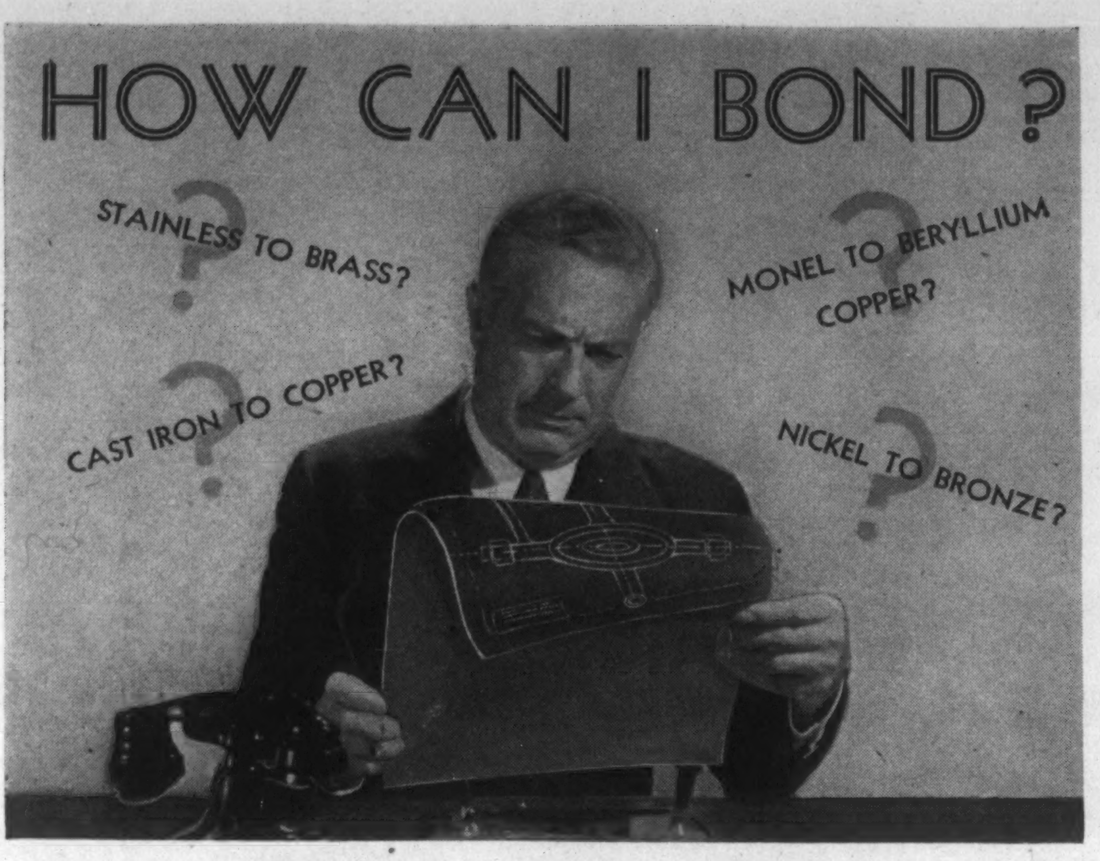
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Fully active at 900° F. (many degrees below active temperature of ordinary fluxes). Here is a low surface tension flux, developed after years of experimentation. Meets all government specifications. For a *completely* satisfactory job, use NU-BRAZE *Flux*, with NU-BRAZE, the easy flowing, low temperature, silver brazing alloy.

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on FAST BRAZING

"New Ways With NU-BRAZE" includes basic data on low temperature brazing, suggested method, types of joints, standard specifications for brazing alloys and other useful facts. This convenient, concise reference material belongs in your files. Ask us to send you a FREE copy.

SPEAKING OF BONDS — The BEST Are U. S. WAR BONDS

tion of white products is from approximately 10 to over 300 times longer with Cronak coated zinc than with uncoated zinc, depending on testing conditions.

To apply the treatment, work is cleaned as for electroplating, following which it is dipped for approximately 10 sec. in a water solution containing 200 grams per liter of sodium dichromate and 6 to 9 milliliters per liter of concentrated sulfuric acid at 20 C. It is removed from the above solution, drained for not over 30 sec., rinsed thoroughly in cold running water, and dried, preferable by air blasting. Details of the above steps, essential for good results, are discussed at length.

Analytical, X-ray, and electron diffraction data lead to the conclusion that the film has the formula $Cr_2O_3 \cdot CrO_3 \cdot XH_2O$. A normal film is about 0.00002 in. thick. Experiments show that the film slowly releases its hexavalent chromium to water, which comes in contact with it, and that the dissolved hexavalent chromium inhibits the corrosion of the zinc.

As long as the film is capable of producing a concentration of 0.0001-5 grams per liter of hexavalent chromium in the water in contact with it, the formation of white corrosion products is prevented. Some experiments show that the trivalent chromium also contributes to the inhibiting action.

Since the mechanism of the film formation involves attack of the zinc by the solution, some loss of zinc occurs. The range of loss is from 0.000003 to 0.0001 in., the higher loss being reached only under the worst conditions.

—E. A. Anderson. *Proc. Am. Electroplaters' Soc.*, June 1943, pp. 6-11.

Special Tools Boost Production

Condensed from "Tool Engineer"

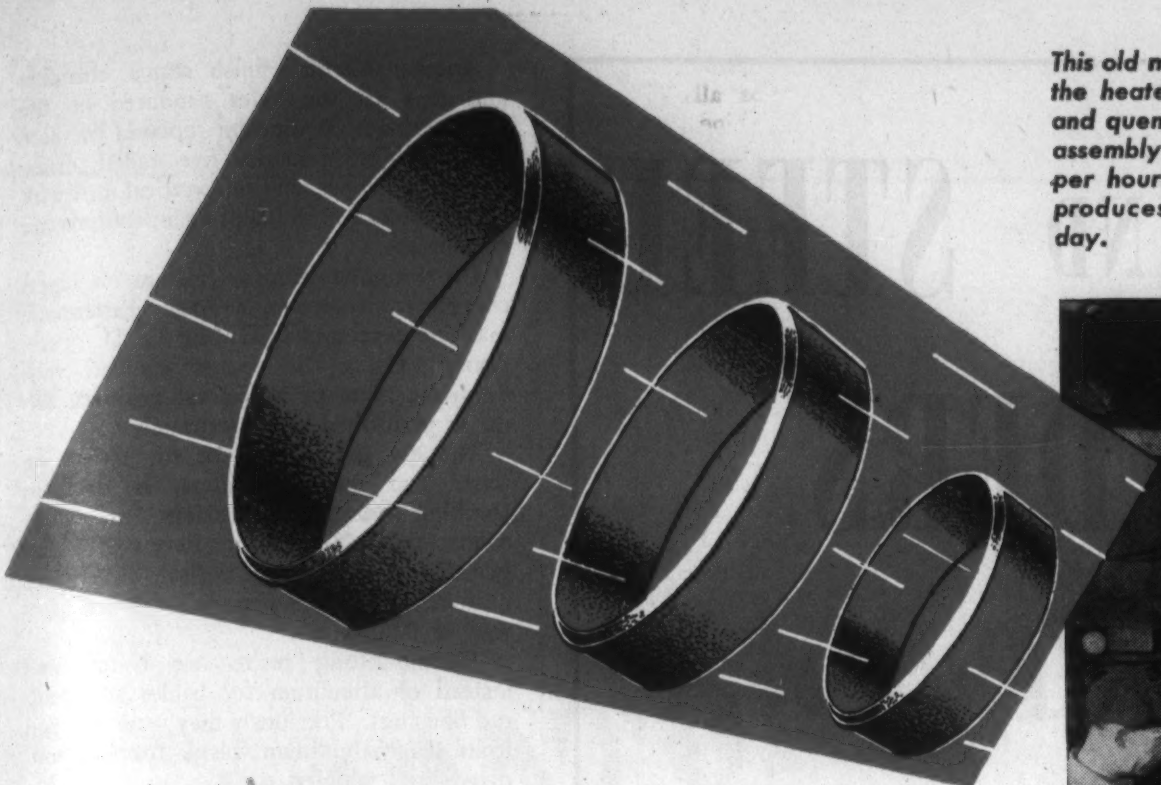
Forging cylinder heads has necessitated the machining of cooling fins, which could not be produced in the forging process. A milling operation is performed with automatic fixtures to guide the milling saw; the space between fins is 0.112 in., and thickness between 0.052 and 0.068 in. A special adaptation of Hydrotel equipment was designed for cutting fins across the dome of the cylinder head.

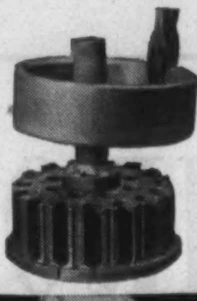
The cutters used are 13 in. in diam., 0.112 in. thick, and operate at 4500 surface ft. per min. A vacuum system pulls the chips out.

The machining of the supercharger front section of the Wright engine makes use of a six-way Greenlee horizontal and angular, 14 station, automatic indexing machine. It rough and finish bores, faces and drills holes.

At the first loading, it rough faces and bores 14 intake parts and seven mounting pads, and rough bores three holes in the oil sump pad.

At the second loading, after changing three tools, it faces and bores 14 intake parts, finish bores seven pads, drills four holes in breather pads, and three holes in oil sump pad.





This old method of putting the heated ring on a jig and quenching the whole assembly produced 8 rings per hour. Super-Cyclone produces 432 rings per day.

The Lindberg Super-Cyclone Keeps Work Straighter

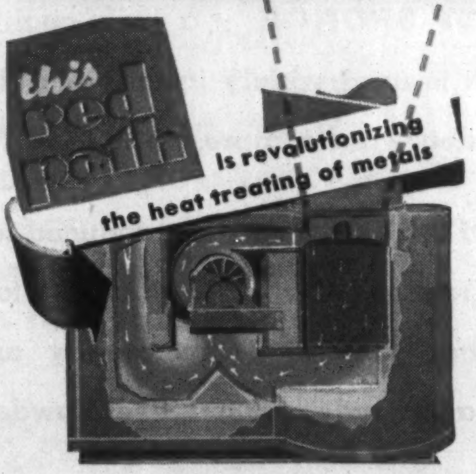
saves time . . . cuts costs

Reducing the need for difficult straightening, or eliminating costly preventive measures, can speed up heat-treating production and save in many ways. The Lindberg Super-Cyclone Furnace is doing just this for users because of the heating principle on which it operates. Fan-driven hot air developed in an isolated chamber builds up temperature with rapid uniformity *throughout the charge* to as much as 1750°F. There is no direct radiant heat to cause distortion.

A bearing manufacturer placed each "race" on a special jig to hold an acceptable "round" after quenching. Produced 64 per 8 hour day. With the Super-Cyclone an operator working only 1½ hours a day, loading 63 rings at a time on a fixture, quenching all at once without jigs, yet holding to within .006" to .010" of round, finished 432 per day—*7 times more production.*

Besides keeping work straighter, saving time and saving space, the Super-Cyclone can be used for normalizing, hardening and tempering, because temperature can be accurately controlled between 300° and 1750°F.

Write for complete information to: Lindberg Engineering Company, 2451 W. Hubbard St., Chicago 12.



LINDBERG FURNACES

ARMY E NAVY

SUPER-CYCLONE for hardening, normalizing, annealing, tempering
CYCLONE for accurate, low-cost tempering and nitriding
HYDRYZING for scale-free and decarb-free hardening

IRON AND STEEL POWDERS

•

A POUND OR A CARLOAD

Regardless of quantity — users of Plastic Metals powders can depend upon uniformity of quality.

PLAST-IRON, produced electrolytically, is the purest form of iron powder now available in commercial lots. It is ideal for applications requiring extreme purity, unusual electrical properties, or maximum densities.

PLAST-SPONGE is a high quality reduced oxide iron powder which is used widely in the field of powder metallurgy due to its high degree of compressibility.

PLAST-STEEL can be produced to a wide variety of customers' specifications. Strength, ductility, toughness, hardness and other physical properties are readily and consistently attainable in compacts made of Plast-Steel Powder.

PLASTIC METALS, INC.

133 Bridge Street,
Johnstown, Pennsylvania

Another machine finish reams, chamfers and taps all the holes produced on the first machine. Equipment replaced by these two machines includes five radial drills, one radial tapper, and one vertical mill with rotary table. Five handling operations are eliminated.

On straight turning operations on supercharger front section, a Foster Fastermatic machine performs I. D. and O. D. operations. Using the present method with duplicate plate in horizontal position, set-up is performed more accurately.

The air gage, a device for measuring inner and outer diameters, is used in checking lead-plated bearings on master connecting rods. Bearings have a 0.001 in. plating of lead, with a flash plating of indium. Tolerance permits an overall leeway of 0.0005 in.

Thermo-setting resins are being used instead of aluminum for baffles and push rod housings. Previously they were stamped from sheet aluminum, blank formed, anodized, and painted.

Reduction of scrapped parts has resulted from the use of Scandia torque machines, which can be pre-set so that the clutch will disengage upon application of tension above the desired.

In one application the crankshaft clamping bolts are tightened until they have stretched 0.009 in. The torque machine does the job faster, and stretches the part to precise fit.

On some machining operations fine aluminum chips cannot be removed with compressed air. Now, a stream of coolant washes them away for salvage recovery. The coolant is also recovered.

A most interesting development is the adaptation of pre-set-up jigs and fixtures. For X-raying, Wright engineers devised a circular table, riding on rollers, with a quadrant section always within the lead-lined X-ray chamber. Lead-lined doors close across the table surface while the machine is in operation.

—*Tool Engr.*, Vol. 12, Nov. 1943, pp. 76-81.

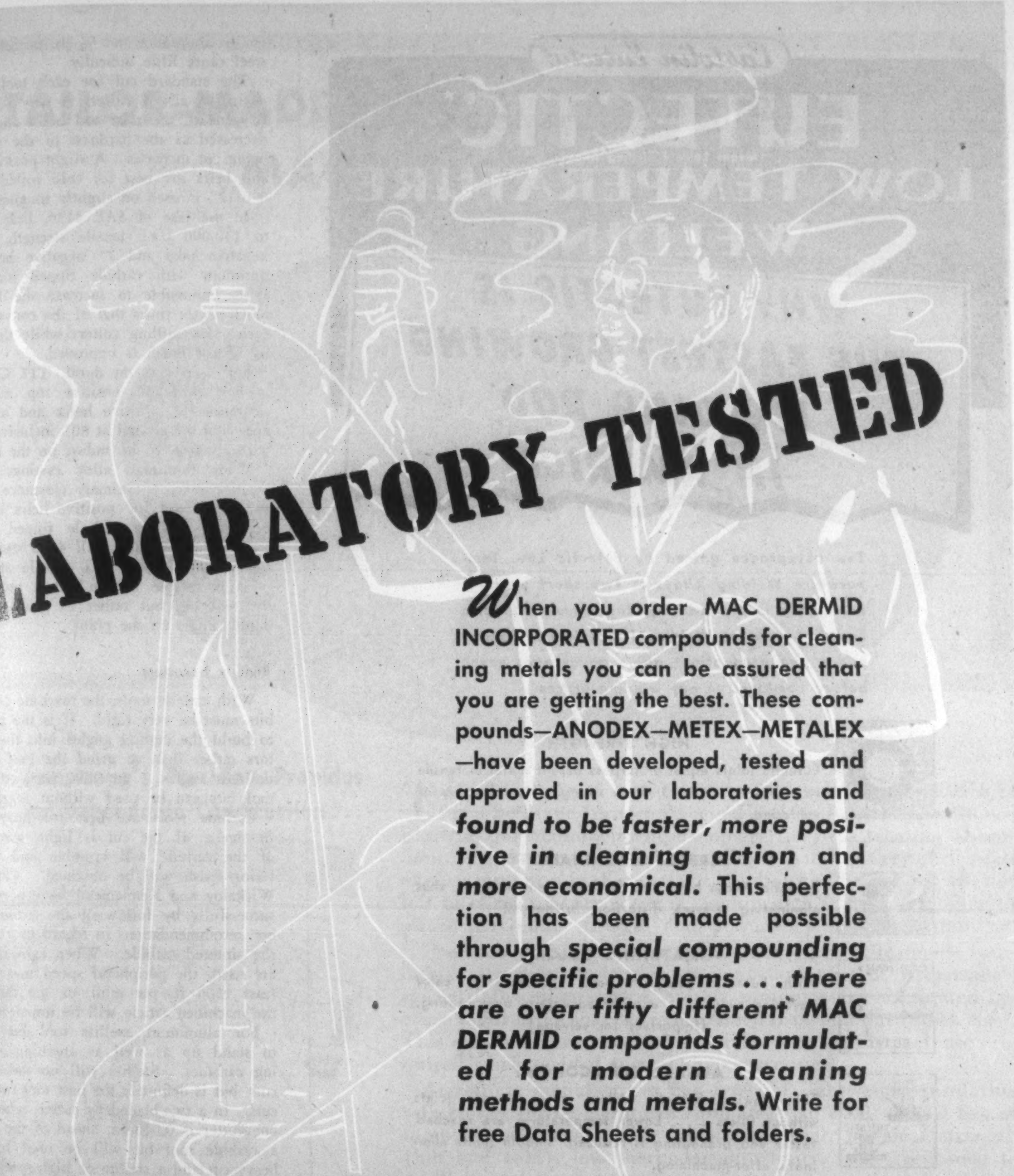
Fly Cutters for Aluminum

Condensed from "Canadian Aviation"

It has been possible to increase milling speeds and feeds enormously by the use of fly cutters. For example, landing gear castings that were milled on a slab mill at 750 sfpm and 5 in. feed were milled with a fly cutter at 4000 ft. per min. (top speed of the machine) and 30 in. feed per min.

As an experiment, an aluminum casting was milled on a wood shaper at 11,500 r.p.m., with a high-speed steel fly cutter ground for wood working; although the finish was a little rough, the material was removed. It is believed that special milling machines will eventually be made that will be capable of 20,000 to 30,000 r.p.m.

The secret of fly cutting is the use of proper cutting angles. In some cases, the difference of ½° may make the difference between failure and success. As far as the depth of cut is concerned, ¼



LABORATORY TESTED

When you order MAC DERMID INCORPORATED compounds for cleaning metals you can be assured that you are getting the best. These compounds—ANODEX—METEX—METALEX—have been developed, tested and approved in our laboratories and *found to be faster, more positive in cleaning action* and *more economical.* This perfection has been made possible through *special compounding* for *specific problems . . . there are over fifty different MAC DERMID compounds formulated for modern cleaning methods and metals.* Write for free Data Sheets and folders.

Compounds and Equipment for Metal Cleaning

MAC DERMID

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Castolin Eutectic*

EUTECTIC*
(Means Lowest Binding Alloy)
LOW TEMPERATURE
WELDING

WHY EUTECTIC IS
THE FASTEST GROWING
WELDING ROD
(for oxy-acetylene, metallic arc, etc.)
IN AMERICA

The acceptance gained by Eutectic Low Temperature Welding Alloys in two short years is unmatched in the Industry. The reason—Eutectic Low Temperature Welding (for salvage, maintenance and production) offers advantages never before combined in any welding process.

HIGH STRENGTH
Eutectic joints equal or surpass parent metal in tensile strength . . . 2 to 3 times stronger than brazing or soldering.

EUTECTIC ALLOY

PERFECT MACHINABILITY
Eutectic Alloys bind at safe, lower temperatures, thus eliminating stresses, distortion, brittleness.

ORDINARY
EUTECTIC

MATCHING COLOR
With Eutectic you can have undetectable, color matching welds . . . another advantage over brazing. (Important for salvage)

ORDINARY
EUTECTIC

ALL-AROUND ECONOMY
Thin flowing Eutectic Alloys give stronger joints without fillets . . . Lower temperatures are reached faster and preheating is reduced. Smooth joints eliminate after-machining.

INVESTIGATE EUTECTIC TODAY
Do you weld cast iron, steel, alloy steel, aluminum, brass, bronze, copper, nickel, nickel alloys, Dow-metal? . . . One of 43 Eutectic rods will do a better job and effect considerable economies in your plant.

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☐ Tool Salvage Instruction Poster
☐ 36 p. Eutectic Data Book
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Company
Address City

in. on aluminum and 1/8 in. on SAE 4130 steel cause little difficulty.

The standard cut for each tool bit in designing all fly cutters is now 0.006 in. In general, the rake and helix angles are decreased as the hardness of the material being cut increases. A slight positive rake and helix are best for cold rolled steels; 0 or 2° is used on slightly tougher steels.

In the case of SAE 4130, heat treated to 130,000 p.s.i. tensile strength, a 12° negative rake and 7° negative helix are optimum with carbide tipped tool bits. It is impossible to increase the feed as much as six times that of the conventional spiral slab milling cutters while the quality of the finish is improved.

For deep cuts on dural, T12 Carboloy is best with 5° positive top rake, 7° clearance, 7° positive helix and a round nose tool bit ground at 80° inclusive angle with about 1/16 in. radius on the nose.

With aluminum alloy castings, a 7° positive rake, 7° primary clearance (front and side) and 10° positive helix are satisfactory. When carbide tipped cutters are used to machine SAE 4130 steel, heat treated to 160,000 p.s.i. tensile strength, it is preferable not to put a radius on the tool bit, but rather to grind with a double angle on the point.

Rigidity Necessary

With carbide tools, the machine and tool bits must be very rigid. It is the practice to build the cutting angles into the adaptors rather than to grind the tool to the desired angles. In this way, standard tool bits can be used without regrinding.

Carbide tools are best for heavy cuts in steel. If the cut is light, the edges of the carbide will crumble and an inferior finish will be obtained. Carboloy, Wickaloy and Kennametal have been used successfully by following the manufacturers' recommendations in regard to grade of the sintered carbide. When carbide tools are used, the peripheral speed must be at least 1500 ft. per min., or the finish of the machined article will be impaired.

For aluminum, stellite tool bits seem to stand up as well as anything including carbides. Stellite will not take deep cuts, but is definitely the best tool for light cuts. In a two-bladed fly cutter, where the one cutter is 0.010 in. ahead of the other, a carbide tool bit will be used for the heavy cut and a stellite or high-speed steel bit for the finishing cut.

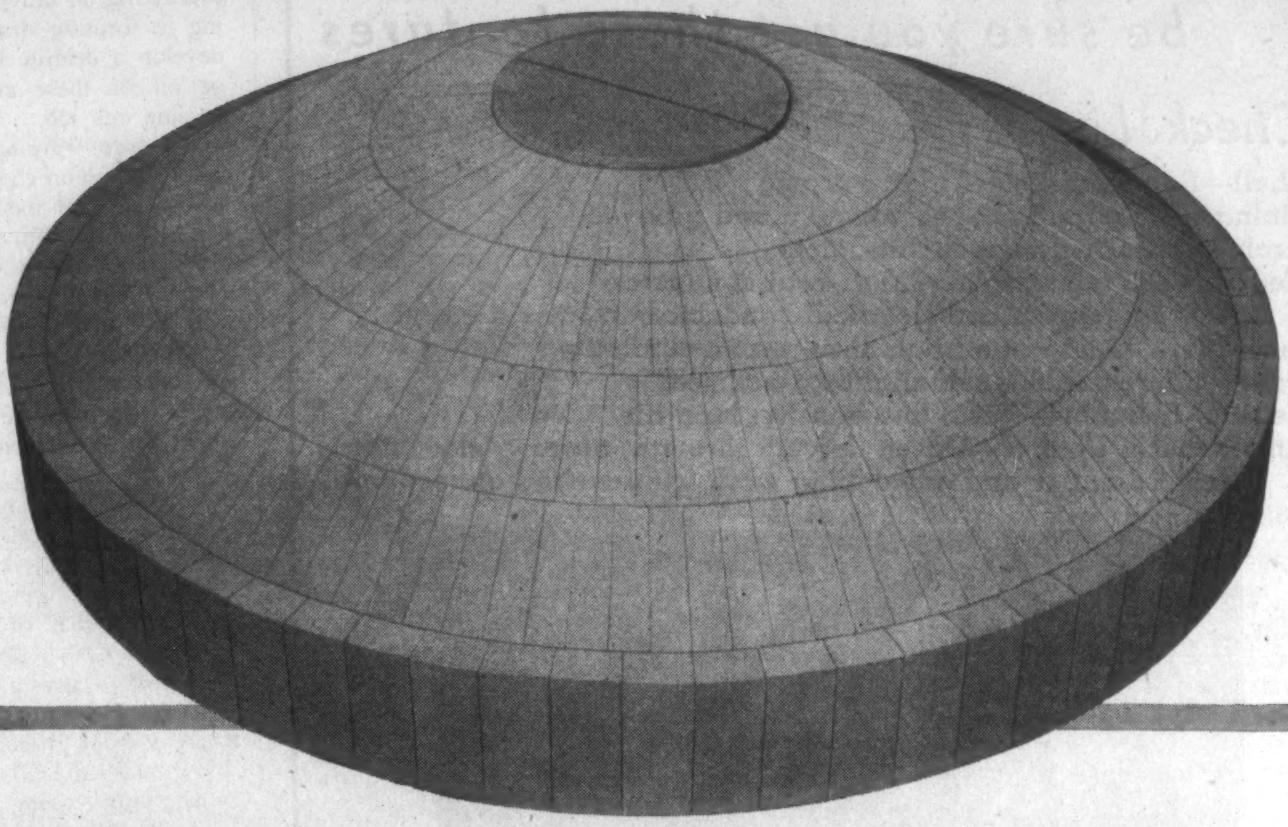
In the case of carbide tools, the life is increased by frequent honing of the edge between grinds. Four hours between grinds is considered average for the carbide tipped tools.

If only one cutter is used, then another tool bit should be fitted opposite it to maintain balance. Wherever possible, climb milling is used, since the rigidity is greater and the bits last longer. In most cases, no lubricant is used. However, there is very little overheating, as the bits are air cooled due to the high speed of operation.

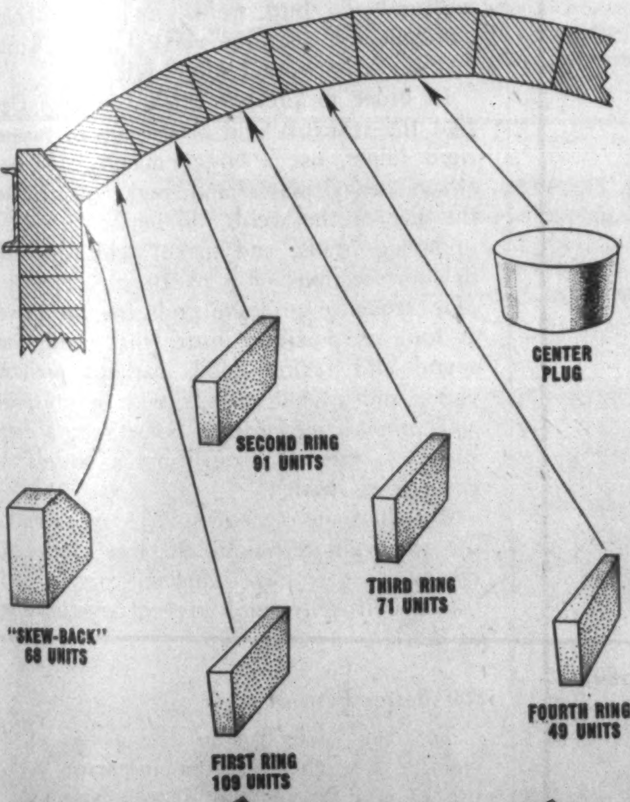
It is felt that fly cutting offers greater promise, and that only the first steps have been taken in investigating this method of cutting.

— G. Fox. *Canadian Aviation*, Vol. 16, Oct. 1943, pp. 79-80; 108

TAILOR-MADE DOMES DESIGNED AND MACHINED TO FIT



Armstrong's Precision Provides For Dependable Construction . . .

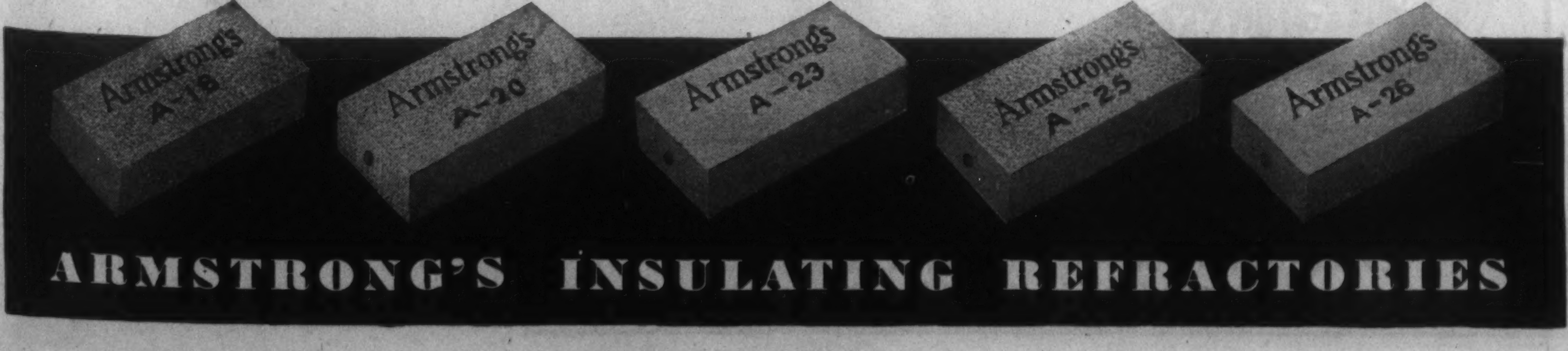

CENTER PLUG
SECOND RING 91 UNITS
THIRD RING 71 UNITS
"SKEW-BACK" 68 UNITS
FOURTH RING 49 UNITS
FIRST RING 109 UNITS

THIS 92″ dome of Armstrong's A-23 Insulating Fire Brick is for a bell-type furnace designed and built by Westinghouse Electric and Manufacturing Company for heat treating aluminum. The sketch shows how Armstrong handles the fabrication of such custom jobs. Keying and bonding the brickwork are not left to chance. Every piece is machined to the proper taper to assure maximum strength and permanent structural stability.

Precision work for domes, arches, and other tailor-made insulating refractory designs is an important part of Armstrong's special fabrication service. Supply problems are eliminated because tailor-made shapes are machined from standard stock sizes. This eliminates the need for a maintenance supply such as is required when molded special shapes are used.

Armstrong manufactures five types of lightweight insulating refractories for temperatures from 1600° to 2600° F. All five of these efficient, dependable brick have high physical strength (hot and cold), low thermal conductivity, high resistance to spalling, and low heat storage.

If you have an unusual insulating refractory application, call upon Armstrong's engineers to help you. Thirty years of experience are behind their sound, practical recommendations. For full information and assistance write to Armstrong Cork Company, Insulating Refractories Department, 5503 Concord Street, Lancaster, Pennsylvania.

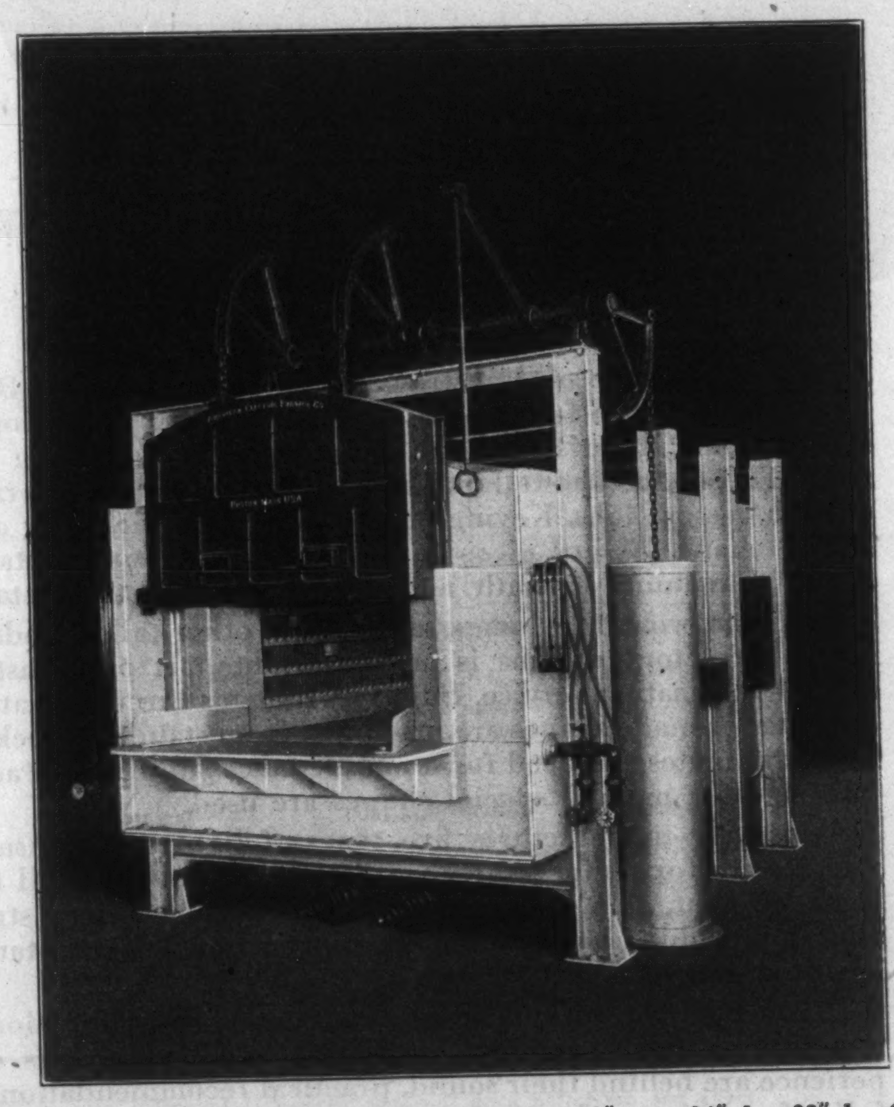

Armstrong's A-18
Armstrong's A-20
Armstrong's A-23
Armstrong's A-25
Armstrong's A-26

ARMSTRONG'S INSULATING REFRACTORIES

LOOK!
at several before you buy
but
be sure you get these features

Check List

Shell—Reinforced steel, non-warping
Lining—Preburned shapes, tongued and grooved
Arch—Preburned shapes, lap joints
Hearth—SiC, nonwarping, high heat conductor
70% supported, non-electrical conductor
Insulation—Composite brick, thru seams eliminated
Door—C.I. insulated, self-aligning, lock seal
Heating Elements—NiCr, low density, long life
Atmosphere Control—Gases forced through narrow slot filling work chamber and enveloping work with desired atmosphere.



The Model B3684 Box Furnace Work Chamber 36" w x 84" l x 22" h. Capacity 850 lbs. per hour. To 1500°F.

ARMY E NAVY

American Electric Furnace Company

29 Von Hillern St. Boston, Mass., U.S.A.
Industrial Furnaces for All Purposes

Common Welding Troubles

Condensed from "Western Metals"

There are five common cures for distortion following welding: Properly clamp or tack parts, preform parts to compensate for shrinkage of welds, distribute welding to prevent excessive local heating, with preheating on heavy structures, remove rolling or forming strains before welding, and develop a definite sequence. One, several, or all of these cures may be employed on any one job.

To cure warping of thin plates there are six common cures: Select electrode with fast speed and moderate penetration, weld rapidly to prevent too much heating near the weld, make spaces small between parts to be welded, clamp parts near the joint correctly and use back-up to cool parts rapidly, use special welding sequence, such as step back or skip and peen joint edges slightly before welding, thus elongating them for subsequent shrinkage.

In the case of welding stresses, move parts slightly during welding, make as few passes as practical, peen each deposit of weld metal, anneal product at 1100-1200 F. for 1 hr. per in. of thickness, and proceed so that all parts are free to move as long as possible.

To avoid spatter, select the proper type electrode, do not use excessive welding current, hold proper arc length, reduce arc blow and paint adjacent parts with whitewash, thus making removal easy.

To avoid undercut, use moderate current and travel slowly; use a small enough electrode, thus avoiding too large a molten puddle; don't weave excessively; weave uniformly in butt welds, and don't hold electrode too near the vertical plane when making a horizontal fillet weld.

In order to prevent cracked welds: Design the structure and proceed to eliminate rigid joints, use a large enough weld between heavy plates and perhaps increase the size of the welds, do not make welds in string beads; and make weld full size in short sections of 8 to 10 in. long, employ sequence to leave ends free to move as long as possible, insure that welds are sound and fusion good, perhaps preheat parts, and prepare joints with a uniform and proper free space. Sometimes a free space is essential; sometimes a shrink or press fit is needed.

To eliminate a poor surface appearance, use the right technique for that electrode, don't use excessive current, weave and travel uniformly, and prevent overheating of work.

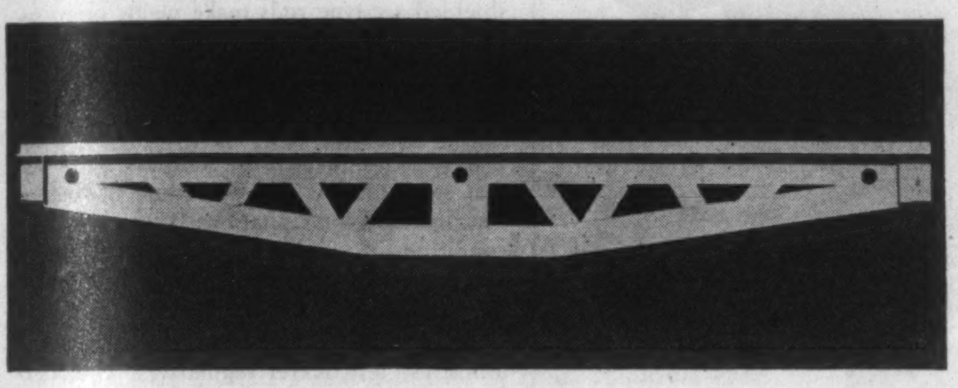
For Better Fusion

To avoid poor fusion, use a rod small enough to reach the bottom in narrow vees; use enough current to deposit and penetrate into the plates, and the heavier the plates the higher the current; weave widely enough to melt well the sides of a joint; sweat the deposited metal onto the plates and do not let it curl away from it.

To prevent incomplete penetration, allow proper free space at the weld bottom, do not expect excessive penetration from an electrode, use small diameter rods in a narrow groove, use sufficient current, and don't weld too fast.

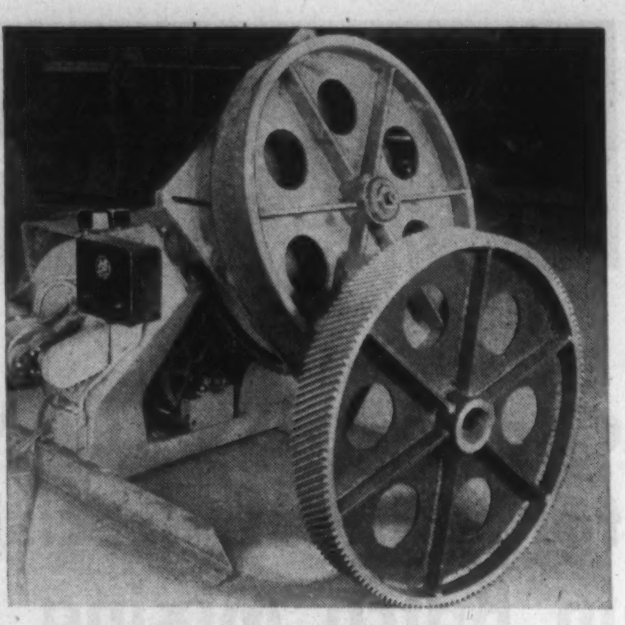
ARC WELDING HIGH LIGHTS

BETTER DELIVERIES of electrodes are the order of the day, thanks to the current higher output of manufacturers, and to the curtailment of certain parts of the war production program. The latest production figures reveal that almost 65% more mild steel, coated electrodes were produced in the first eleven months of 1943 than in the corresponding period the previous year. Deliveries now generally may be made in weeks instead of months; and certain types of electrodes can be shipped immediately. *However, fabricators should continue to order as far ahead as possible, as this enables electrode manufacturers to anticipate and meet the specific demands for various types.*



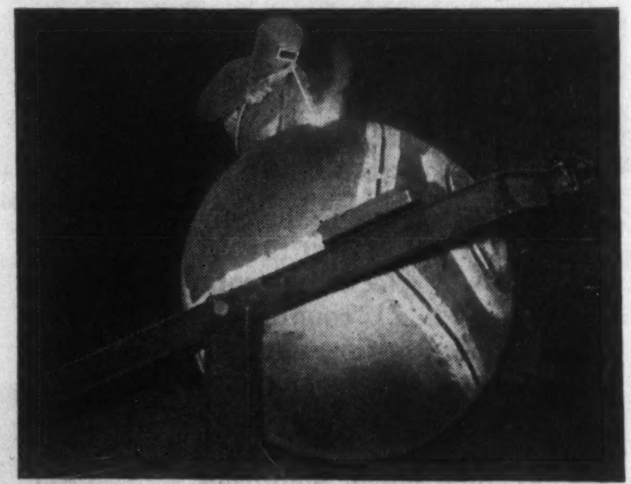
HATCH SHIFTING BEAM saves ten tons of steel per ship. Twenty feet long, weighing 1,125 pounds, these beams are produced in quantity by the Globe Company of Chicago. Welding is done in ten specially designed fixtures, each of which aligns and holds parts in position as they are welded. Quarter-inch reverse polarity rods are used for welding the lacings and gussets and 7/32" Murex Type FHP for the intermittent fillet welds that attach the long plate to the top of each beam.

THE ELECTRIC MACHINERY MANUFACTURING COMPANY of Minneapolis, a leading designer and manufacturer of synchronous motors, reports that arc welding has taken the place of cast construction in pedestal bearings, stator frames, and bases. Welding approximately halves weight; produces greater rigidity and sturdiness; permits variations of design at small cost. Overall savings are estimated at more than 30%.



ARC WELDING IS A 50% TIME-SAVER as compared with casting in the fabrication of heavy gear blanks, according to the Ransome Concrete Machinery Company, Dunellen, New Jersey. Murex Types F and FHP "hot" rods used at high currents permit rapid deposition of weld metal and result in smooth, uniform welds of great strength.

SPHERICAL ANTI-SUBMARINE NET FLOATS by the thousands are built by Brown Steel Tank Co., Minneapolis. Each float is fabricated from six segments of 3/16 inch steel plate. Positioners are used. Welds are made from the outside, using ¼" Murex Fillex electrodes. These floats withstand salt water submergence tests to a depth of 250 feet.



MURAX

MUREX

ARC WELDING ELECTRODES

METAL & THERMIT CORPORATION

120 Broadway, New York 5, N. Y.

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SOUTH SAN FRANCISCO · TORONTO

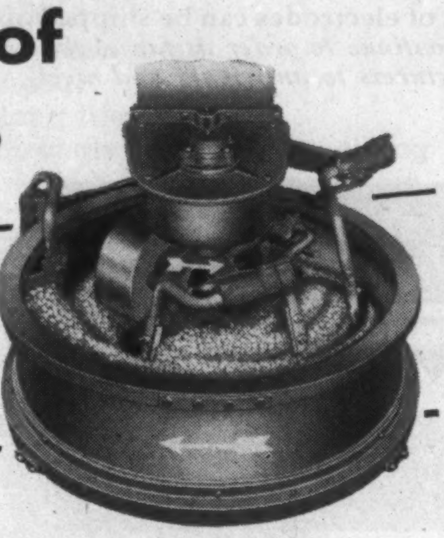
Specialists in welding for nearly forty years. Manufacturers of Murex Electrodes for arc welding, and of Thermit for repair and fabrication of heavy parts.

Lancaster MIXERS

THE SCIENTIFIC COUNTER-CURRENT RAPID BATCH MIXING SYSTEM

Choose the "LANCASTER" for Critical Precision in Batch Mixing of Powdered Metals

Only Mixer that Combines Counter-Current Mixing with Balanced Mulling Action



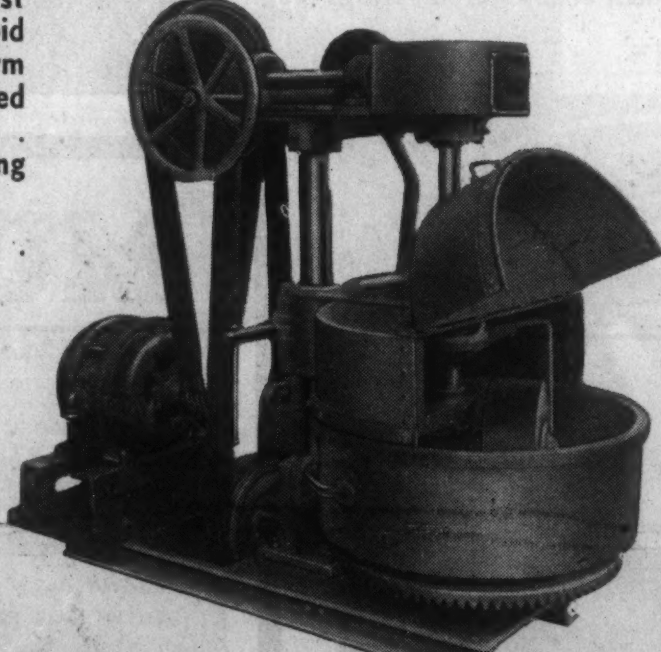
A part of the science of powder metallurgy is precision blending of the many alloying formulations. Scientific action of "Lancaster" Mixers assure precision control throughout the entire range.

The "Lancaster" is the only mixer which combines the two best factors of scientific mixing—(1) clockwise rotation of the mixing pan; (2) counter-clockwise rotation of the mixing plows and mullers. "Lancaster" Mixers mix fast . . . clean quickly. Their rapid . . . dependable . . . uniform performance means improved man-hour productivity . . . better results from processing operations.

"Lancaster" Mixers . . . used for some thirty diversified mixing processes including Powdered Metals . . . are available in 9 unit sizes and 32 models. Recommendations to suit your individual requirements will be submitted promptly upon request. No obligation.

(Above) Illustration shows how material is conveyed by clockwise rotation of mixing pan and deflected by stationary side wall plow into the path of counter-clockwise rotating plows and muller which are established off-center of pan diameter.

(Below) "Lancaster" Mixer, Symbol SKG. Closed pan type, fitted with liftable mixing head and demountable pan.



LANCASTER IRON WORKS, INC.
BRICK MACHINERY DIVISION
LANCASTER, PENNA., U. S. A.

To guard against porous welds, use the proper rods, for some produce sounder welds than others; puddle or keep the metal molten long enough, weave to eliminate minute pinholes caused by a series of strung beads; do not use excessive welding currents; check the base metal for segregation and impurities, and do not hold too short an arc.

To avoid brittle joints, preheat medium carbon steel or certain alloy steels to 300-500 F., to prevent the heated zone from becoming hard from rapid cooling. Remember that multiple layer welds will tend to anneal hard zones—sometimes anneal at 1100-1200 F. after welding to soften hard areas, sometimes use austenite electrodes on steels that harden readily as the increased weld ductility will compensate for the brittle heat-affected area in the base metal.

In the matter of corrosion, remember that bare type electrodes produce welds that are less resistant than the parent metal; shielded arc-type rods make welds more resistant; don't expect more from the welds than from the parent metal, and on stainless steels use rods equal to or better than the parent metal.

With 18-8 austenitic stainless steel see that steel analysis and procedure fit to prevent carbide precipitations, correcting the condition if necessary by annealing at 1900-2100 F., and carefully clean all slag in materials, such as aluminum.

To avoid irregular weld quality, weave uniformly and travel regularly, use moderate currents, use a rod suitable for weld type and position of welding, and prepare all joints properly.

Finally, to avoid magnetic arc blow, locate the ground on the work properly, such as placing of the ground in the direction the arc blows from the point of welding; perhaps separate the ground in two or more parts; weld toward the direction the arc blows; hold a short arc; change the magnetic path around the arc by using steel blocks, and use a.c. welding.

—C. H. Jennings. *Western Metals*, Vol. 1, Dec. 1943, pp. 18-23.

Glue for Polishing

Condensed from "Monthly Review," American Electroplaters' Society

Thousands of tons of glue are used annually in the United States for polishing metal products. A high-grade animal glue of properly balanced jelly strength, viscosity, melting point and flexibility should be used. It should be free from odor and bacteria.

Large users of glue and suppliers' laboratories test glues for the above properties. If it is impractical for the consumer to make these tests, it is important that the glue be purchased from a reliable firm specializing in glue for polishing.

Glue must be stored in a cool dry place. If it gets wet, it will spoil rapidly due to growth of bacteria.

The proper proportions of glue and water in amounts sufficient for a 4 or 5 hr. supply are carefully weighed and placed in

*Phos-Copper** FOR *Brazing*

SAVES TIME · MATERIALS · MAKES SOUNDER JOINTS

AND IS *Immediately Available!*

Industry, today, is brazing many parts which were formerly drawn, cast, machined or forged—for brazing is producing important savings not only in men, materials and machines, but also in money and minutes.

For example, if you are now machining parts out of brass, bronze or copper, in many cases you can do the job faster and better by changing over to stampings that can be assembled and brazed. Or, if you are now brazing nonferrous metal parts with high temperature, hard-to-handle alloys or expensive silver solders, specify Westinghouse Phos-Copper and you will reduce rejects, speed output and cut manufacturing costs.

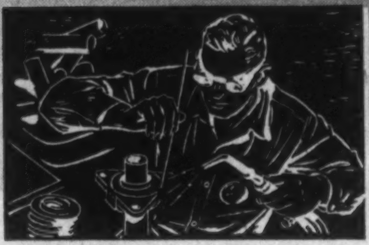
Brazing with Phos-Copper is *fast*. It flows free and smooth at 1382° F., cutting application and assembly time to the bone. And in many applications, Phos-Copper is successfully replacing hard-to-get tin solders.

With any brazing method, you will save time, money, materials, and get sounder, tighter joints with Phos-Copper, and . . . it's immediately available. Ask your Westinghouse Office for a sample for an on-the-job test.

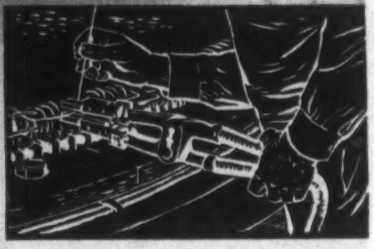
NEW PHOS-COPPER BOOKLET. Get your copy of the new Westinghouse brazing bulletin B-3201. It explains ways to braze, how to make good brazes, proper joint design, and gives complete application photographs and details about Phos-Copper. Westinghouse Electric & Mfg. Company, East Pittsburgh, Pa., Dept. 7-N.

J-91035

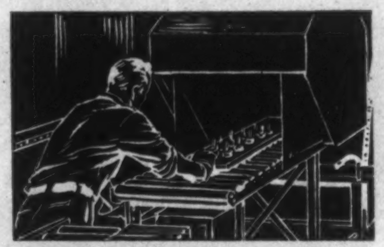
WAYS TO BRAZE WITH PHOS-COPPER



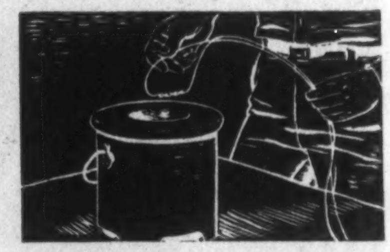
GAS BRAZING—with oxyacetylene torch . . . most widely used method.



"TONG" BRAZING—also called incandescent carbon brazing . . . saves time and materials.



ELECTRIC FURNACE BRAZING—for mass production brazing of a wide variety of parts.



DIP BRAZING—in either metal or chemical bath, heated by gas or electricity.

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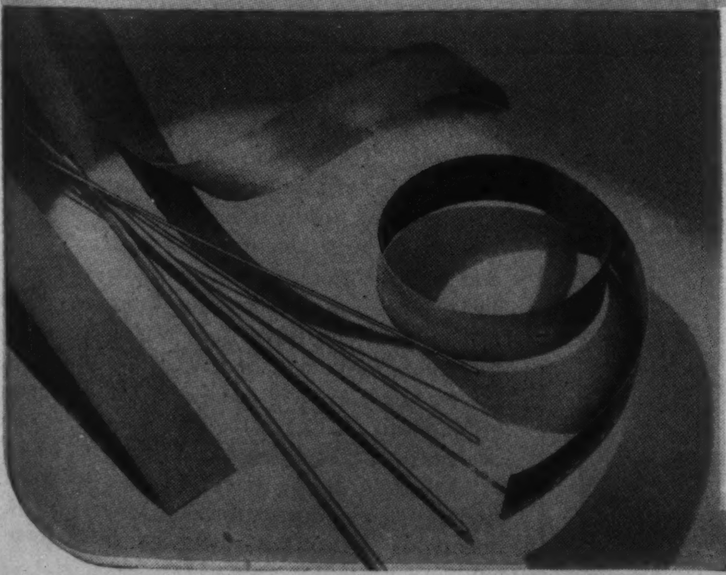
PHOS-COPPER



IMMEDIATE DELIVERY ON ALL SIZES AND SHAPES OF PHOS-COPPER

ROD: Ideal for face-feeding—particularly where torches are used. Sizes: $\frac{1}{16}$" to ¼"—36" long. Small sizes are excellent for joining small parts.

RIBBON: Used especially for inserts. Comes .015" thick by 1.25" wide in various lengths. Approximately 16 feet per pound.

SPECIAL SHAPES: Popular for "tong" and furnace brazing. Preplacement of Phos-Copper makes mass production brazing possible and economical. Rings, strips, thin ribbon, diameters smaller than $\frac{1}{16}$", etc., can be supplied for special applications.

*Phos-Copper is an alloy of phosphorus and copper used for brazing copper, brass or bronze joints.

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FURNACES

MAGNESIUM
DIE-CASTING

Battery of
HAUSFELD
600 lb.
Magnesium
Furnaces in
Die Casting Plant

Photos courtesy of
ARMSTRONG CORK CO.
Lancaster, Pa.

The Campbell-Hausfeld Co.
200-220 MOORE ST. HARRISON, OHIO

sterile pots to soak. Ground glue should soak one hr., flake glue 3 to 6 hr., sheet glue 5 to 10 hr. or overnight. It may be allowed to soak as much as 1 or 2 days in covered containers, though this practice is not recommended.

When soaking is complete, the pot is placed in a hot water bath or melter to melt the glue. It should be stirred during melting with a sterile hand or mechanical stirrer. Melting must not be done over an open flame or other high temperature heat source.

Prolonged heating must be avoided, as the viscosity and jelly strength is thereby reduced, with consequent loss in polishing wheel life. Ten hours cooking at 175 F. reduces both the viscosity and the jelly strength by about 50%.

The actual reduction depends on temperature, time and glue concentration. A glue pot temperature of 140 to 150 F. should be used. A separate brush should be used for each pot to avoid contaminating glue and wheels with oversize abrasive. The brush should be hung in the pot to prevent it from drying out.

The correct glue concentration depends on the grain size of the abrasive being used, finer grains requiring a more dilute glue.

At the end of each day any "cooked out" glue (heated over 10 to 15 hrs.) should be discarded, and all pans, brushes, etc. sterilized with Lysol or a similar disinfectant. Although it is a common practice to use cooked out glue for sizing, a very great increase in wheel life will be obtained if a new glue solution is used for sizing.

Wheels should be properly cleaned, balanced and faced before being re-headed. If sizing is required, it is applied and dried. The wheel is then recoated with glue and the abrasive or "head" rolled on. The following 1 or 2 hr. of drying are critical.

Either low or high drying temperatures will reduce the wheel life. It is recommended that wheels be dried at 80 to 85 F. and 50 to 60% relative humidity. A dried wheel may be "broken" with a pipe, but it is better to crack the head by rolling the wheel against a small diameter roll.

—LaV. Verzier. *Mo. Rev., Am. Electroplaters' Soc.*, Vol. 30, Oct. 1943, pp. 890-897.

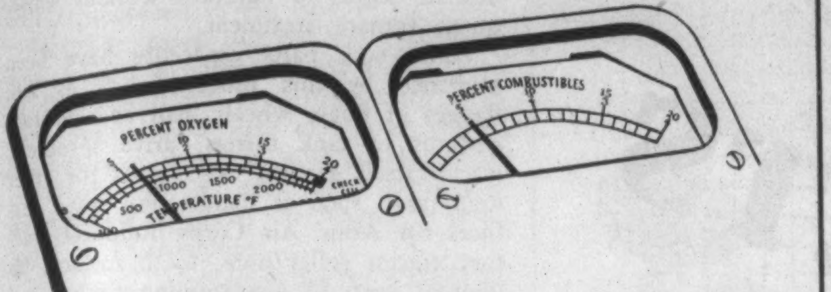
Ordnance Flame Hardening

Condensed from "The Welding Journal"

Peacetime heat treating facilities would have proved a bottleneck had not war-time methods, such as flame hardening, been adopted. This process afforded rapid and flexible means of heat treating, readily adaptable to production operations without the use of large quantities of scarce metals, and with the minimum amount of floor space used. A few months prior to Pearl Harbor a new technique was developed, that of simultaneously hardening and tempering.

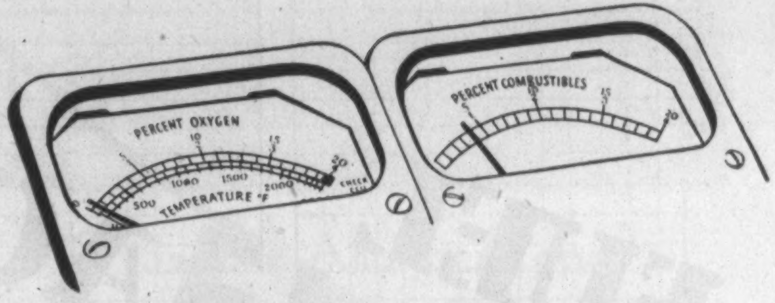
Material under treatment is progressively heated by a multiflame oxyacetylene burner, followed immediately by a quenching stream to produce surface hardness. The quenching stream is followed at a pre-

How to Control Furnace Atmosphere



Make this Test

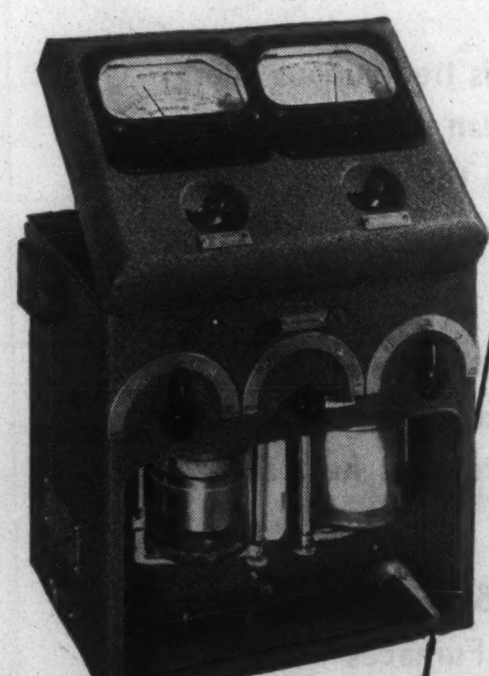
Have a Cities Service Engineer, with the aid of the Industrial Heat Prover, take a test reading* of any combustion equipment in your plant. Note percentage of needless excess oxygen in the furnace atmosphere as registered on the Heat Prover dials.

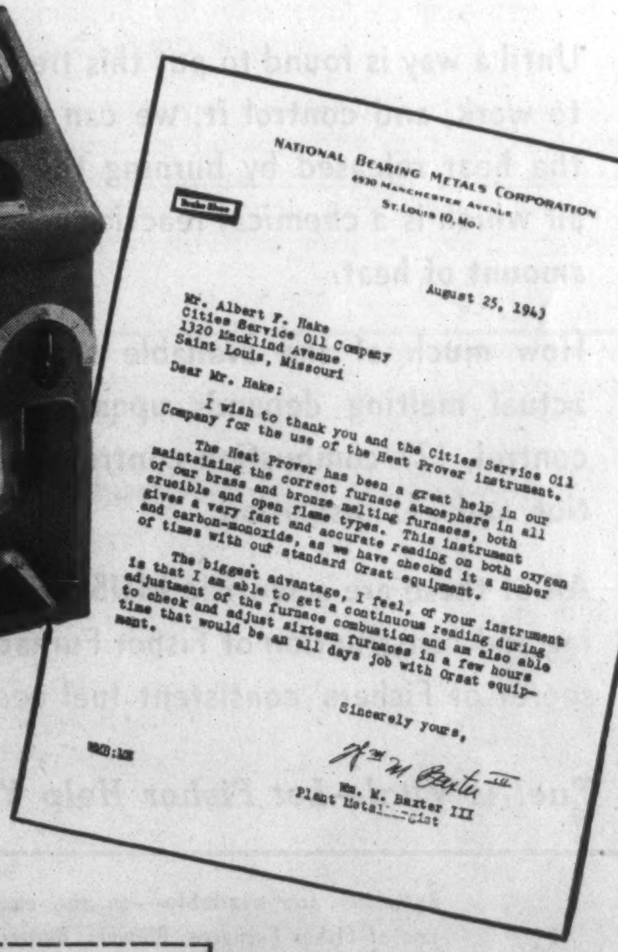


See the Results

The Cities Service Engineer may then evaluate the Heat Prover analysis against his data and curve charts which are the Standard of Efficiency for the particular equipment . . . and make recommendations for correcting the defect—which in this case would reduce excess oxygen to ½%.

THE CITIES SERVICE HEAT PROVER reveals the degree of waste caused by air deficiency (excess fuel), or the degree of waste caused by dilution (excess air). Through unique means these conditions are measured directly on the two Heat Prover dials . . . one indicates the percentage of unused combustibles, and the other the percentage of excess oxygen which may be present in the spent gases. These readings are continuous and can be made at any instant from combustion samples taken from any part of the furnace, pit or crucible atmospheres.





NATIONAL BEARING METALS CORPORATION
4930 MANCHESTER AVENUE
ST. LOUIS 10, MO.

August 25, 1943

Mr. Albert F. Hake
Cities Service Oil Company
1320 Macklind Avenue
Saint Louis, Missouri

Dear Mr. Hake:

I wish to thank you and the Cities Service Oil Company for the use of the Heat Prover instrument.

The Heat Prover has been a great help in our maintaining the correct furnace atmosphere in all of our brass and bronze melting furnaces, both crucible and open flame types. This instrument gives a very fast and accurate reading on both oxygen and carbon-monoxide, as we have checked it a number of times with our standard Orsat equipment.

The biggest advantage, I feel, of your instrument is that I am able to get a continuous reading during adjustment of the furnace combustion and am also able to check and adjust sixteen furnaces in a few hours time that would be an all days job with Orsat equipment.

Sincerely yours,

Wm M. Baxter III

Wm. M. Baxter III
Plant Metallurgist

WMB:AM

*Mail this Coupon

TODAY FOR AN INDUSTRIAL HEAT PROVER TEST OF YOUR EQUIPMENT—AT NO COST OR OBLIGATION TO YOU.

CITIES SERVICE OIL CO.
Room 157
Sixty Wall Tower
New York 5, New York

Gentlemen: Please contact me regarding your Industrial Heat Prover Test.

Name____________________

Title____________________

Company____________________

City____________________

(Available only in Cities Service Marketing Territory East of the Rocky Mountains.)

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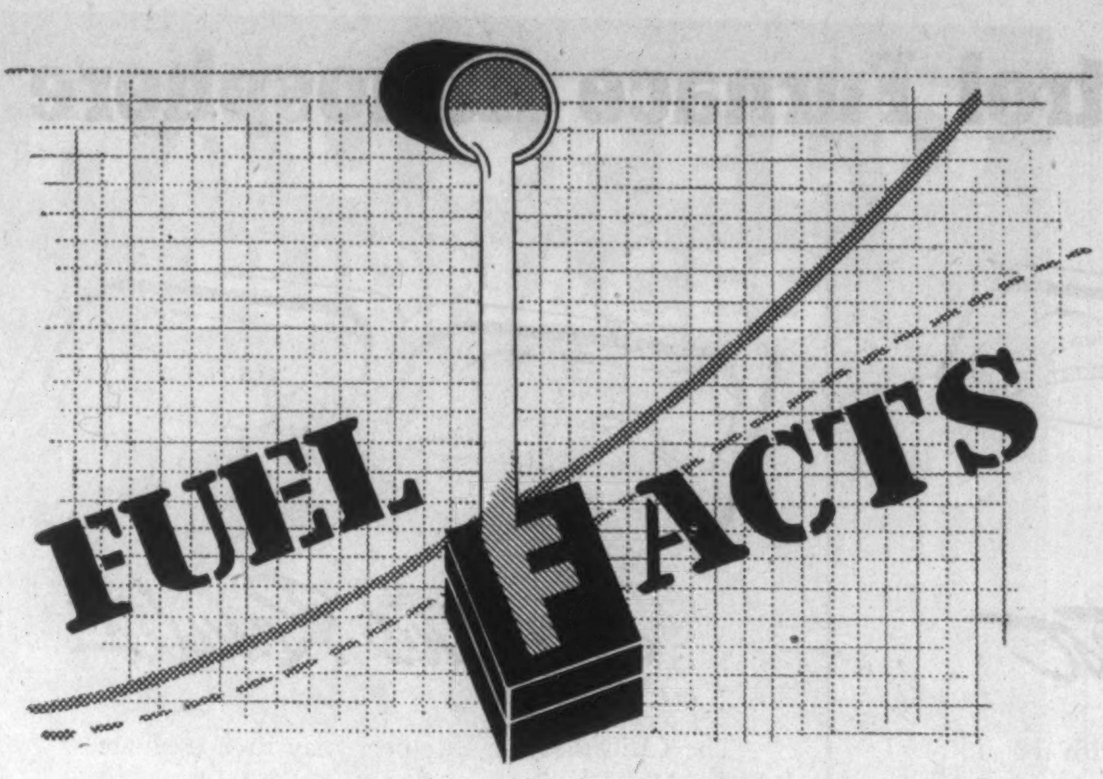
ONCE-ALWAYS

CITIES SERVICE OIL COMPANY
ARKANSAS FUEL OIL COMPANY



According to science, the amount of heat or energy in molecules of gas or oil is practically limitless.

Until a way is found to put this tremendous energy to work, and control it, we can only hope to use the heat released by burning the gas or oil with air which is a chemical reaction releasing a certain amount of heat.

How much of the available heat is utilized for actual melting depends upon (1) fuel mixture control, (2) combustion control, (3) heat absorption and (4) insulation.

All of these are scientific MUSTS in the engineering and construction of Fisher Furnaces — and the secret of Fishers' consistent fuel economy record.

Fuel is Vital—Let Fisher Help You Save It!

Bulletins are available—on the complete line of Fisher Furnaces, Blowers, Burners and Refractories for crucible or pot type non-ferrous furnaces—write for any or all of them. Present your layout problems to Fisher.

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Fisher FURNACE COMPANY

Engineers and Manufacturers

determined distance by a soft multiflame oxyacetylene burner, which heats the hardened surface to a proper drawing temperature, thus producing the desired intermediate surface hardness. This permits any surface to be completely flame hardened in one continuous operation to any desired degree of hardness without subsequent furnace treatment.

Army tank parts especially have been hardened by this process, such as rim flanges of bogie wheels, ball bearing race surfaces of tank turrets, drive sprockets, tractor tread grouses; also, parts for other than tanks such as flanges and tread surfaces for Army Air Corps bulldozer tractors, tractor roller hubs, tooth surfaces on internal gears of gun training circles, and gear teeth generally.

When rubber became scarce, less was used in tractor treads of tanks and steel was substituted, the grouser being a vital part. All steel grousers are now flame hardened, making this the largest ordnance item to be heat treated by flame hardening.

A typical process is that used on bogie wheel rims that have to resist stones, etc. which become wedged between the treads and these rims, the process being that of the Cleveland Welding Co. The rims are made of fine-grain modified SAE 1035 steel plate, rolled to the proper section at the mill.

After cutting to length, cold forming to circular form, flash welding, cold sizing the diameter and facing the sides to proper width, the rim is ready for flame hardening.

The initial hardness of the rolled plate from the mill is 150 to 160 Brinell, increased to 170 to 190 in the cold forming and sizing operations. Specifications require that both flanges of the rim be hardened to 287 to 360 Brinell.

Rims are mounted manually on a compressed air expanding chuck that is foot-controlled by the operator. The chuck is located on a sliding table, which is moved sideways out of the flame hardening position by a hand lever. When chucked, the rim is moved into hardening position and the torches are lighted.

Wheels are rotated at proper speed by an electric motor. Two standard welding torches, one for heating and one for tempering, are mounted on each side of the wheel with standard heating tips directed at the flanges, thus hardening and tempering both flanges simultaneously at 8 in. per min.

Water Quenching Jet

A water quenching jet is between the heating and drawing flames. The heating tips are extinguished after one revolution, and the rim continues to rotate until the starting point, which has been hardened by the quench, passes under the drawing tips, whereupon the rim is completely flame hardened and drawn in one simultaneous operation.

Other operations on other items are largely modifications of this process. When changes in materials or hardness specifications are made, corresponding changes in gas operating pressure are decided upon with only a short interval needed.

When hardening sprockets at the plant of S. M. Howes, Inc., Taunton, Mass., half of the sprocket is immersed in a circulating water bath and the sprocket is turned on a mandrel so that half of the sprocket is always exposed to the air and subject to flame treatment while the other half is quenched in the tank.

In many cases torches are completely water cooled to withstand the intense heat of the operation. Some extremely large parts are handled, such as an 8-ft. roller bearing ring, which is progressively hardened in 1 hr., 17 min. in a multiflame oxyacetylene burner at the Messinger Bearing Co., Philadelphia.

—Stephen Smith, *Welding J.*, Vol. 22. Nov. 1943, pp. 911-919.

Press Forming of Monel

Condensed from
"Western Machinery and Steel World"

The following directions have proved useful for the blanking, cupping, drawing and other operations encountered in the press forming of the nickel-copper alloy, Monel, commercially pure nickel, and the nickel-chromium alloy, Inconel.

Shearing: Shearing of these alloys requires slightly more power than soft steel of the same thickness, but neither this nor the strength of the shear need be considered unless the job involved is close to the capacity of the equipment. Shear blades must be set up tightly and kept sharp.

Perforating: Because of the toughness of the high-nickel materials, the minimum hole diameter that can be punched economically must be larger than the thickness of the sheet up to approximately 5/32 in. to 3/16 in. For heavier plate, the minimum diameter of the hole may be equal to the thickness of the sheet.

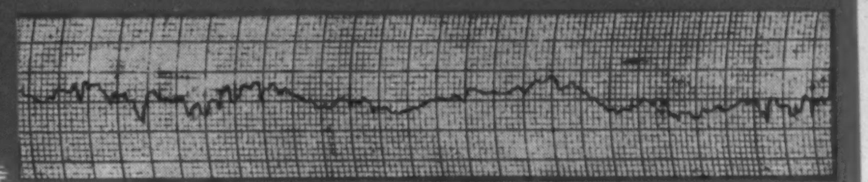
For ¼-in. and heavier plate, it is often desirable to use slightly less die and punch clearance than for steel. A close clearance should be maintained between the punch and the stripper plate. Punches and dies should be made of alloy steel, heat treated to a tough temper (Rockwell C 58 to 61).

Two types of steel are generally recommended: (1) Oil-hardened manganese die steel (0.90 C, 0.50 Cr, 0.30 W and 1.25% Mn); or (2) 18 W, 4 Cr, 1% V high-speed steel containing 0.71 to 0.76% C.

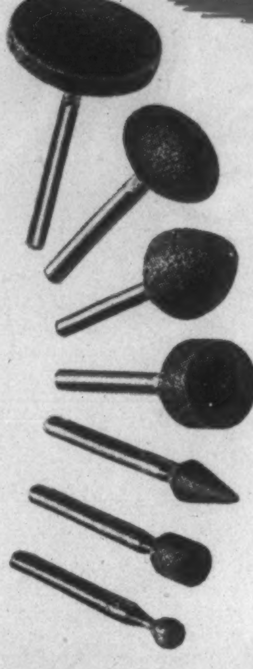
If possible, punches should be designed stronger than for ordinary practice. They should be kept well dressed, as defective hole edges result in fatigue failure. A thermal stress relief treatment, after preheating, will increase the fatigue life of a screen. If the perforated sheet is to be severely cold worked, annealing is recommended.

Pressing: Most of the deep-drawn shapes produced in the high-nickel materials have been drawn over dies and formed with tools laid out to handle steel or copper-base alloys. Where the shapes were particularly intricate, requiring accurate finished dimensions, it has been necessary to increase the clearance or en-

Proof of a Better Finish



Each small square represents 1.0 micro inches. Micro inch r.m.s. = 0.8 — 1.8.



Surface Analyzer Tapes Show You Get a Better Finish With Chicago Wheels

These results were obtained at a rate of 10 pieces per hour in an aircraft parts plant. Material, X-13-15, Rockwell 60 to 57, grinds out .006 to .007 stock. Chicago Wheel used, ½ x ½ x ⅛", Grain 180, Grade L Arcite. Spindle Speed 40,000 r.p.m. Lapping and super finishing eliminated on this job.

Can you match that finish? Sounds phenomenal, but you can do the same thing with Chicago Wheels.

Squint your eye along the surface, test it by "feel" or be scientific and use a surface analyzer to measure your finish in micro inches—you'll find that Chicago Wheels give you better finishes, hold closer tolerances and have longer life. They're mighty fast, too; are often spoken of as "bottle-neck busters."

One of the secrets behind Chicago Wheels' superiority is the exclusive bond formula developed, as a result of 50 years' experience making grinding wheels.

Now Featuring Wheels Up to 3" in Diameter

For the duration, with full WPB approval, we are specializing on the small sizes—anything up to 3" in diameter.

Write for Catalog and we will include Engineering Survey Forms helpful in getting the right solution to your own grinding problems.

CHICAGO WHEEL & MFG. CO.

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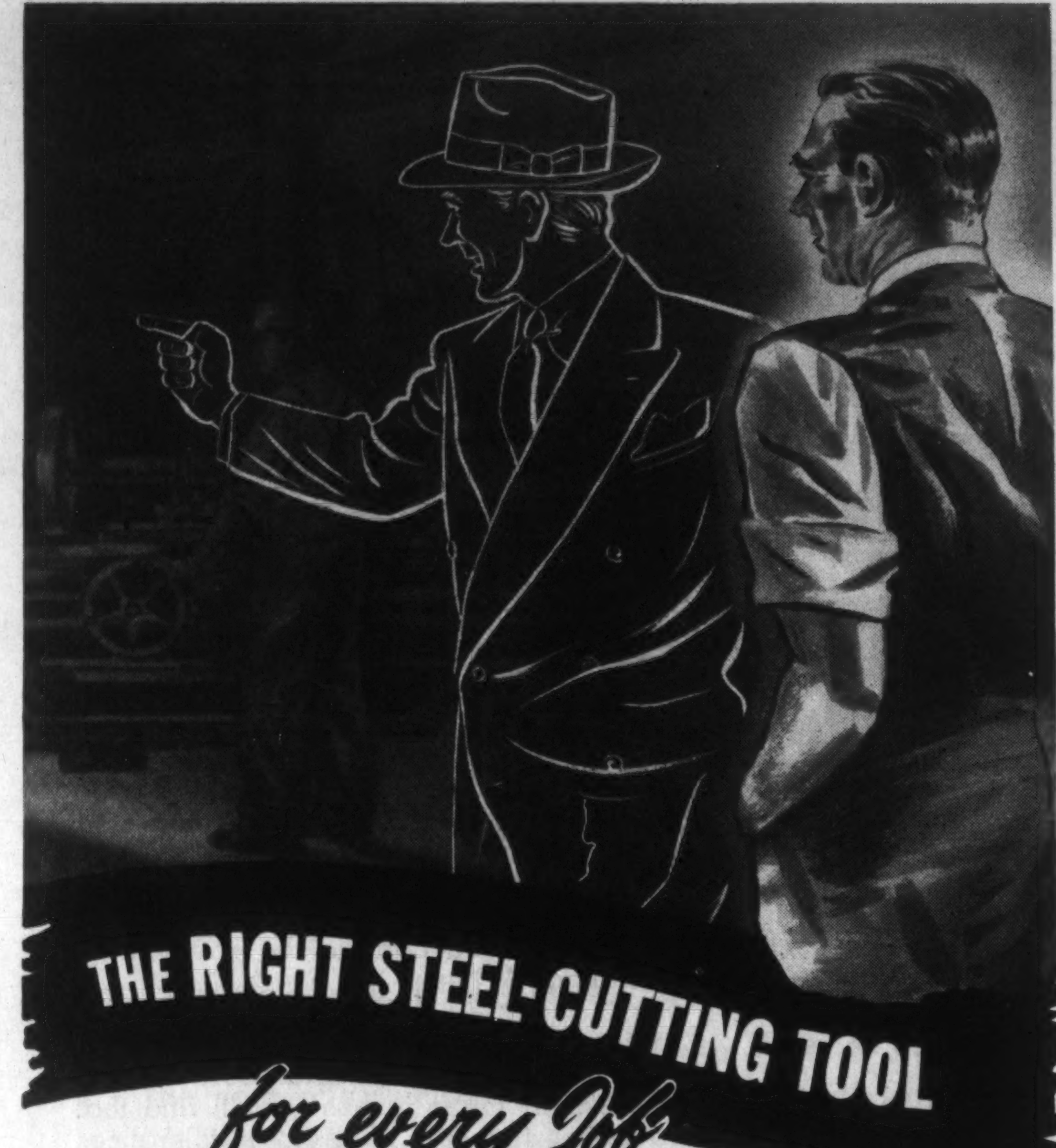

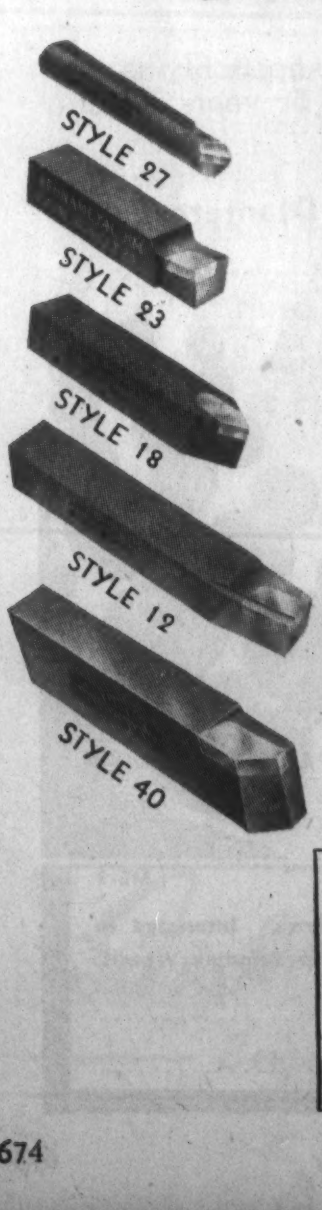

To get maximum steel-cutting production—consult KENNAMETAL field engineers about the proper application of KENNAMETAL, the wear-defying tool material whose chief ingredient is a unique, super-hard intermetallic compound (tungsten-titanium carbide). KENNAMETAL engineers will help you . . . (1) select the right grade . . . (2) choose the correct tool style . . . (3) determine the most efficient machine set-up . . . (4) install a money-saving tool maintenance program.

Yes, KENNAMETAL engineering service assures the *right* KENNAMETAL tool on every job . . . and performance studies show that the *right* KENNAMETAL tool, used properly, often can remove stock from the toughest steel up to 3½ times more efficiently than other carbides! There's a KENNAMETAL field engineer in your locality. Ask him for advice—and always keep a copy of our Tool Manual on hand. Write for one today.

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SUPERIOR CEMENTED CARBIDES

large the radius of the die ring or punch to obtain the full value of their ductility in drawing.

For large production runs and difficult draws, it is essential to have: (1) Special lubricant and die material to minimize friction; (2) dies that permit the freest possible flow without wrinkles; (3) uniform and constant blank hold-down pressure; (4) slow and smooth action press with ample power; and (5) satisfactory annealing equipment.

Material: Monel, nickel and Inconel are each furnished in two types of sheet for deep-drawing and stamping. Monel sheet No. 35 is suitable for press break forming and perforating, but not for stamping or pressing.

Standard cold-rolled sneets are supplied with two finishes — as rolled, or ground, satin. They are furnished in soft temper only. They can be used for moderate drawing and stamping operations.

Special cold-rolled sheets and strips have higher ductility. They can be obtained in tempers from dead soft to full hard. Soft temper sheets and strip, with fine to medium grain, are most suitable for deep-drawing.

—*Western Machinery & Steel World,* Vol. 34, Nov. 1943, pp. 92-94.

Forged Shot Saves Steel

Condensed from "American Machinist"

Many tons of critical alloy steel have been conserved through the use of the Schnell method of press forging 20-mm. and 37-mm. armor piercing shot from lengths of bar stock, since steel requirements are less than when these shot are machined from bar stock. The hot-forging technique was developed by Arthur E. Schnell, a production executive of Aluminum Industries, Inc.

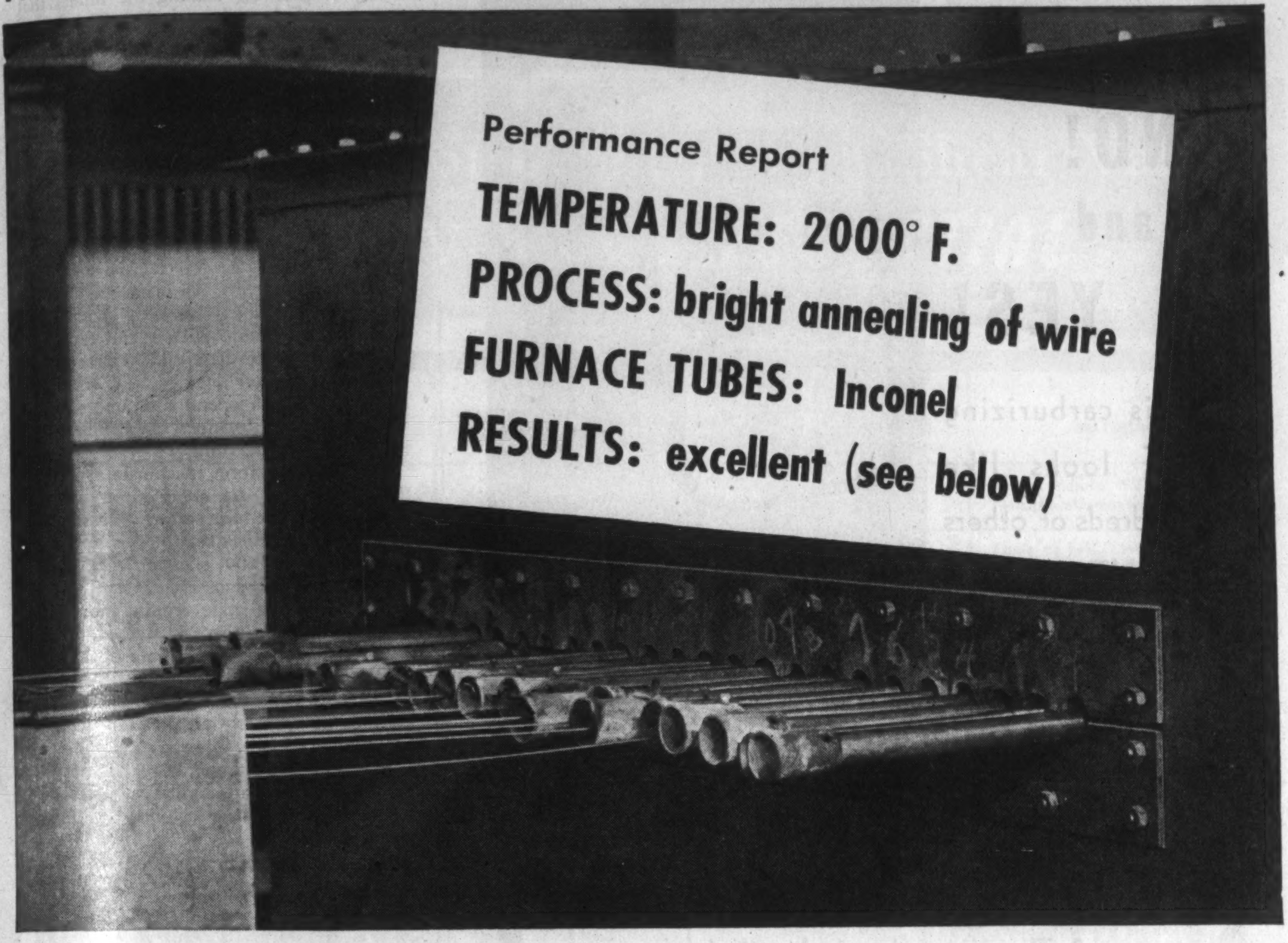
An etched longitudinal cross-section of a 20-mm. armor piercing shot, forged by the Schnell method, indicates the reason why shot made by this process have qualities superior to those produced by machining from bar stock. Pressing the hot billet into the forging die causes the grain lines to converge at the nose of the projectile, thus giving it superior shattering or penetrating qualities.

Another advantage of the process is that bar stock is smaller in diameter than that required for the finished projectile can be employed. The press forging operation which produces a shot is performed with one stroke of the press.

A hot billet is dropped into the cavity. Downward movement of the punch forces the hot billet to fill the cavity and extrude a ¼-in. diam. teat about ½ in. long into the hole extending down from the bottom of the cavity. This extrusion action is the secret of producing the converging grain lines at the nose end of the projectile.

The production of small armor piercing shot by Aluminum Industries, Inc., has been done as far as possible on equipment already in place in the plant when the war

PAGE for the Record*


Performance Report
TEMPERATURE: 2000° F.
PROCESS: bright annealing of wire
FURNACE TUBES: Inconel
RESULTS: excellent (see below)

In bright annealing furnaces of the Pittsburgh Steel Co., stainless steel wire moves continuously through tubes at 2000° F.

Within the tubes, a hydrogen and nitrogen atmosphere is maintained to prevent oxidation of the hot wire surface.

Inconel cold-drawn seamless tubing is used in Pittsburgh Steel Co. furnaces . . . as it is in general use in other bright annealing furnaces . . . because of the service it gives in this high-temperature application.

In the bright annealing of Nickel and Monel wire at 1900°–1950° F. . . . two years' life is reported for Inconel tubing, through the use of wire drawing lubricants free of lead and sulphur.

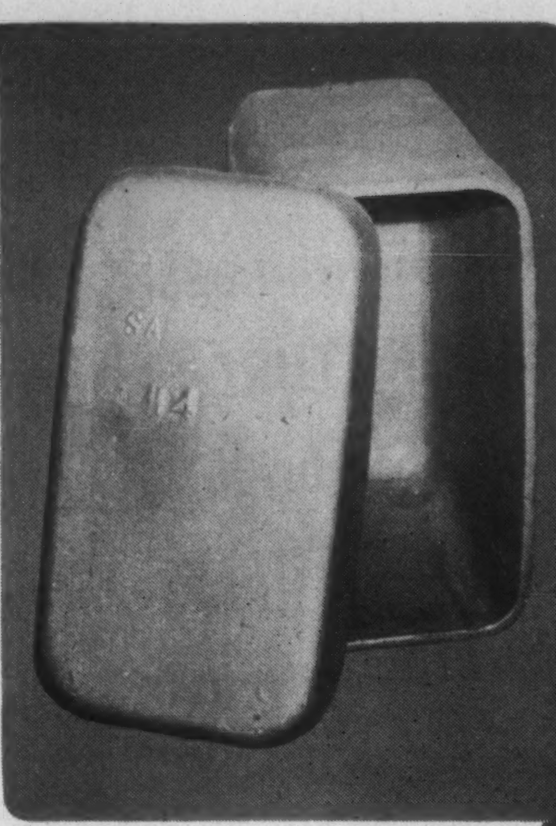
⁂

*The details of this use of Inconel, a wrought nickel-chromium, heat-resistant alloy, are published in the belief that they will be of interest and value to engineers and designers working on similar problems, although the use of Inconel today is subject to approved applications. The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

★ ★ ★ ★ ★ **INCO NICKEL ALLOYS** ★ ★ ★ ★ ★

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL

Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings



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NO!
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2. Accurate and thorough foundry practice
3. The proper chemical analysis
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mean in practice. Your problems in heat or corrosion resisting alloy applications will have the personalized attention of our highly skilled and experienced personnel—May we help you?

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INDIANAPOLIS
C.L. Robertson Company
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DETROIT
C. C. Miller
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started. It was necessary to purchase a rotary furnace for heating the billets that are sheared from bar stock. The billets as cut off drop through a hole in the bolster of the press onto a steel tray, from which they are shoveled into tote boxes.

The sheared billets are moved by wheelbarrow or tote box to the rotary type furnace for heating to the forging temperature. The hot billets are delivered by a steel chute to the forging press. After forging, the shot are spread on steel plates for cooling.

The extruded teat on the nose end of each shot is cut off. To make the abrasive cut-off operation as simple as possible, a foot-operated clamp is used, and each shot is gaged from the base end to ensure uniformity of cut-off lengths. Working at normal speed, an operator of one of these abrasive cut-off machines can handle about 30 to 35 shot per min.

To insure uniform machinability, all of the forged shot are annealed in box-type furnaces. To reduce scaling, the shot are packed in covered boxes for this operation. About 500 to 600 shot of the 20-mm. size can be packed in each box.

The annealing cycle requires about 7½ to 8 hr. The furnace charge is brought up to a maximum temperature of 1550 F. held for 1 hr., and then gradually reduced to 1050 F. in about 4 hr. The shot are then dumped on steel plates on the floor for cooling.

Machining operations on the 20-mm. and the 37-mm. shot are similar to those used by most other manufacturers of forged projectiles.

—*Am. Machinist,* Vol. 87, Dec. 9, 1943, pp. 106-108.

Descaling Heat-Treated Parts

Condensed from "Metal Finishing"

The Bullard-Dunn process is widely used at the present time because of the large amount of heat-treated work done today that must be descaled completely without dimensional changes. The process removes scale and oxide from ferrous metal surfaces by electrochemical means. A film of metallic tin is electrodeposited on the work simultaneously with the scale and oxide removal. This deposit of tin protects the work surface from pitting and etching.

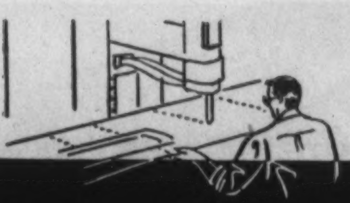
The complete process consists of one or more of the following three main steps:

(1) Grease removal. This is accomplished by anodic electrolytic cleaning in a hot alkaline bath.

(2) Scale and oxide removal. This is carried out in a bath which contains sulfuric acid, a low concentration of tin, and an addition agent that promotes formation of a uniform, adherent tin deposit, increases the throwing power of the bath, and reduces its surface tension. The bath is operated at a moderate temperature and at a high current density.

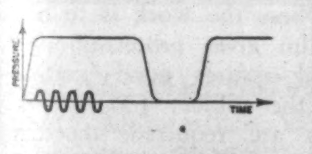
The anodes are high-silicon iron, except for the one or two tin anodes that fur-

SCIAKY HAS A MACHINE FOR YOUR LIGHT GAUGE FERROUS WELDING PROBLEM . . .

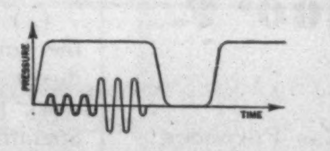


Wherever Consistent, High Shear Value Spot Welds are ESSENTIAL

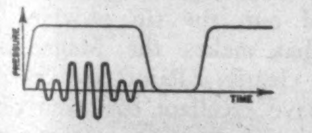
TYPE	KVA RATING	THROAT DEPTH	WELDING RANGE	SPEED S/M - THK.	MAX. PRES. 90# AIR	SPECIAL FEATURES (SEE BELOW)	MATERIALS
PMCO.1-11 PRESS TYPE	60	24"	.020-.125	180 - .032	2600	1	Monel Metals, Mild, corrosion-resisting zinc-coated steels
PMCO.1-12 PRESS TYPE	60	24"	.020-.125	180 - .032	2600	2, 4, 6	Same as PMCO.1-11 plus: ordinary black & high tensile steels
PMCO.1-13 PRESS TYPE	60	24"	.020-.125	180 - .032	2600	3, 4, 5, 6	Same as PMCO.1-12 plus: some air-hardening & chrome-molybdenum steels
PMCR.1-3 ROCKER ARM	60	24"	.020-.090	180 - .032	2600	1	Same as PMCO.1-11 plus: Pickled Steels
P-1-R PORTABLE	90	*	.020-.080	*	*	1	Same as PMCR.1-3
PMCO.2 PRESS TYPE	190	34"	.032-.250	80 - .064	4000	2, 4, 6, 7	SAME AS PMCO.1-13
PMCO.2-1 PRESS TYPE	190	34"	.032-.250	80 - .064	4000	3, 4, 5, 6, 7	
PMM.2-1 SEAM WELDER	700	34"	.020-.064	400 - .040	2140	1	Monel metals, low carbon & corrosion resisting steels



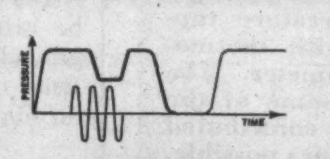
1. WELDING CURRENT ONLY



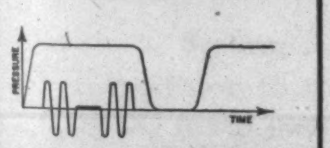
2. PREHEATING AND WELDING CURRENT



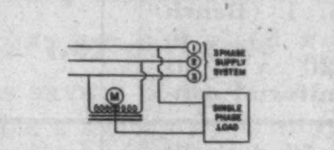
3. PREHEATING, WELDING AND ANNEALING CURRENT



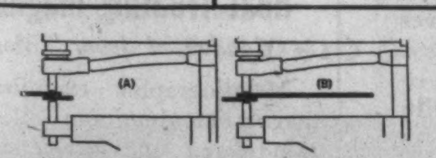
4. VARIABLE PRESSURE



5. ADJUSTABLE QUENCH TIME



6. CURRENT DIVIDER



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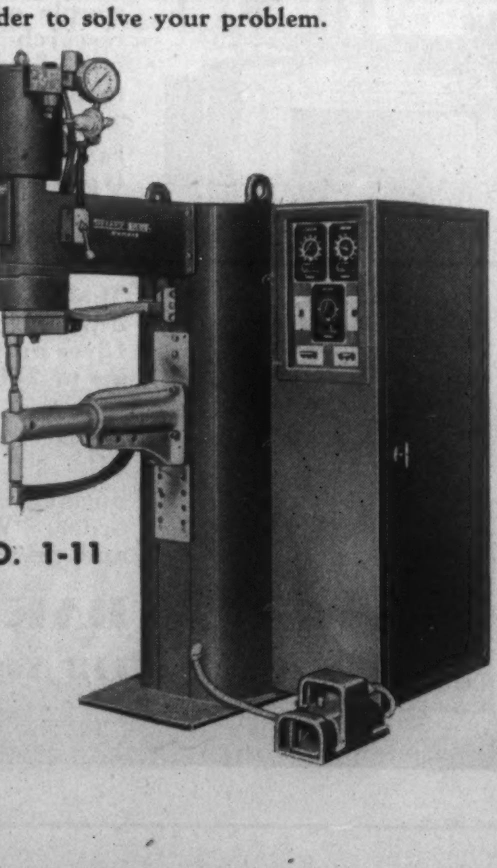
These a.c. machines are specifically designed for the welding of light gauge steels. They deliver the high pressure and precise currents necessary in welding structures subject to stresses and vibration. Wherever high quality welds and fast, dependable operation is the requirement, you will find a Sciaky welder to solve your problem.



PMCO. 1-11

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Manufacturers of a Complete Line of
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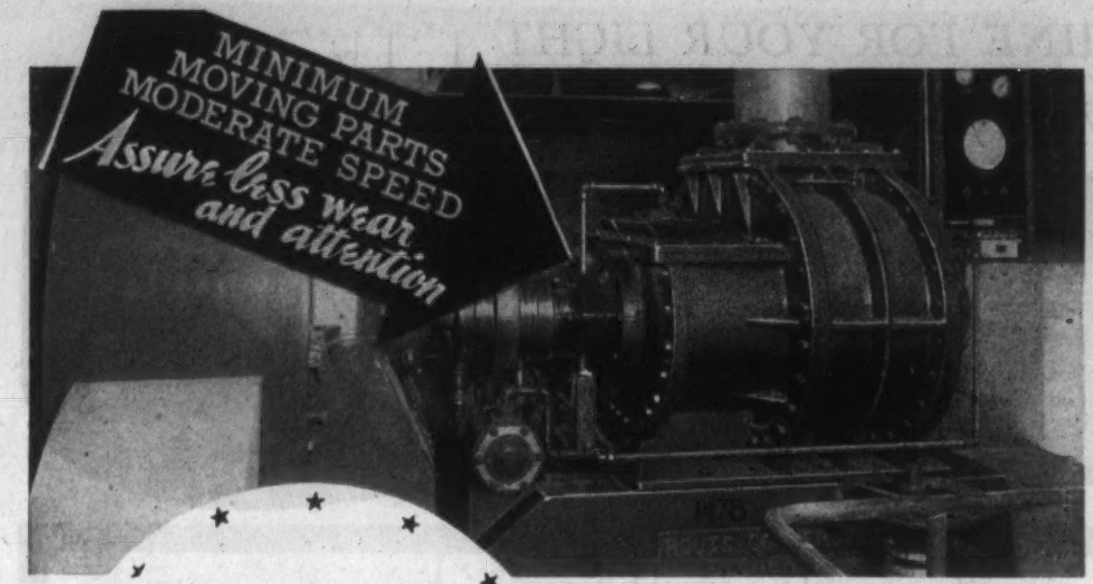

Installation shown in photo is a Roots-Connersville single stuffing box cycloidal gas pump. Capacity 5,200 c.f.m., 20 lbs. maximum pressure, 690 r.p.m., direct connected to variable speed motor.

Based on a conservative life-period, "R-C" Rotary Positive Displacement Blowers and Gas Pumps will move more air or gas per dollar invested—with less upkeep per year of service. Capacities up to 40,000 c.f.m., steam or motor drive.

Because internal lubrication or liquid seals are not required in the impeller chambers, "R-C" Pumps and Blowers deliver clean, dry air or gas. Write for Bulletin.

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403 Superior Ave., Connersville, Ind.

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SINCE 1854

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Baker Gas Furnaces

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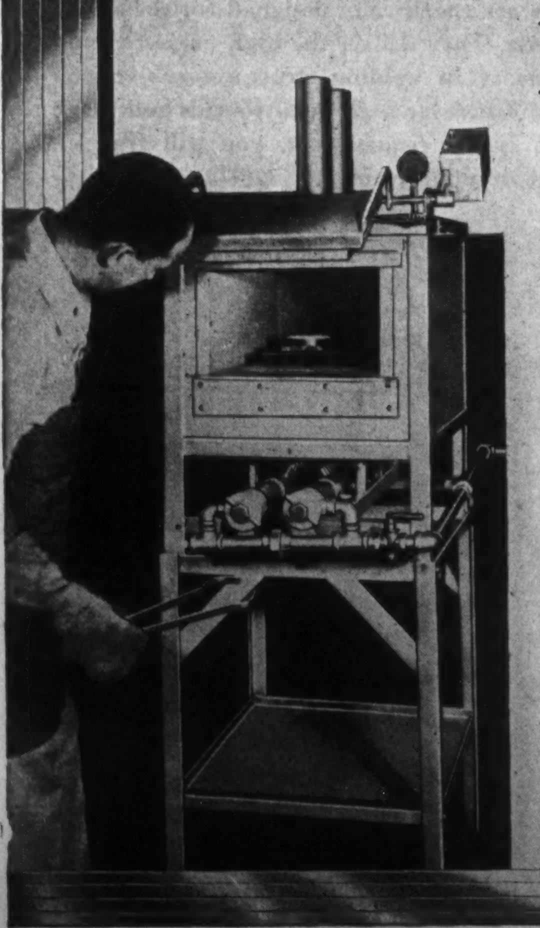
WITHOUT A BLOWER



BAKER Blowerless Gas Furnaces are very low in gas consumption, noiseless in operation, reach the required temperature rapidly and are equipped with thermocouple and accurate pyrometer. The research departments of some of the largest corporations have contributed to making their high efficiency possible.

There are 9 standard stock models ranging in size from No. 1 (Bench type), which is 6" x 8" x 5½", to No. 24, which is 12" x 20" x 8" as illustrated. All provide uniform, controlled heat up to 1900° F.

Model No. 5, 6" x 12" x 5", is built especially for treating high speed steel. Gives uniform, controlled temperatures up to 2400° F.

We stock one Hydrogen Atmosphere furnace, No. 12, with a closed muffle 8½" x 15" x 2½" high.

Special size furnaces built to your order. Write for descriptive folder and prices.

BAKER & CO., INC.
113 Astor St., Newark, N. J.

nish the tin content of the bath. The tin deposit not only protects the work surface from etching, but also imparts to the bath an exceptionally good throwing power, enabling it to clean out holes and recesses.

(3) Defilming or stripping of tin. This is carried out in the alkaline cleaner. The time required is 30 sec. to one min.

The work is rinsed in cold water between each of the above steps. If the work has no grease or carbon film on its surface, the alkaline cleaning is omitted. If for some reason the tin is to be left on, the stripping is omitted.

Work to be blackened is treated in the blackening bath after defilming and rinsing. Work to be bonderized is dipped in a 1 to 2% oxalic acid solution for 1 to 2 min. after defilming and rinsing. Parkerizing and Parco Lubrite do not require the oxalic acid treatment.

Since the tin film affords some protection against corrosion, the practice before the war was to leave it on unless it was necessary to remove it, *e.g.*, in preparation for plating. Since tin conservation is now necessary, the recommended practice is to strip the tin.

Among the advantages of the process not already mentioned are: (1) The solution has a long life, since iron buildup is from scale only, not from solution of the base metal itself; (2) the process lends itself well to conveyorized handling; (3) there is no permanent hydrogen embrittlement. Embrittlement can be relieved quickly by heating to 290 F. for one hr. or to 400 F. for one-half hr.

Among the applications where it is desirable to leave the tin on the work are the following: (1) Where hot-dipped coatings are to be applied, as in the centrifugal casting of bearings; high or low tin-bearing babbits adhere equally well.

(2) Where the work is to be soldered, the tin film gives protection against acid fluxes and assures good wetting of the work by the solder; (3) where drawing operations are required, the tin coating serves as a lubricant.

(4) Where Magnaflux inspection is to be carried out, the tin provides a background that makes the Magnaflux lines stand out clearly. Paint coatings over the tin film have excellent corrosion resistance.

—**Frank H. Bunker.** *Metal Finishing*, **Vol. 41, Nov. 1943, pp. 704-705, 727.**

Heat Treating Magnesium Alloys

Condensed from "Metal Industry"

Metallographic examination of binary magnesium-aluminum alloys in the solution-treated and precipitated state shows that four general forms of precipitate are produced. The higher the temperature and the longer the time, the coarser is the form of the precipitate, the best mechanical properties being obtained when the precipitate is fine.

Four main forms of beta precipitation can be distinguished from studies. The

(Continued on page 682)

Harden it for 10¢ with TOCCO

PROGRESSIVE *Kearney & Trecker Corp.,* Milwaukee, Wisc., reports the following savings by TOCCO hardening the above saddle clamp eccentric of their Milwaukee Milling Machine:

	FORMER METHOD	TOCCO
Heat treating	$ 0.721	$ 0.099
Straightening	0.752	0.000
Cleaning	0.100	0.000
Total Cost	$ 1.573	$ 0.099

Saving . . . $1.47 per piece

In addition to this saving of $1.47 per piece, TOCCO made possible a switch from alloy steel to S.A.E. 1045 steel, saving $0.110 in material cost per piece.

Total saving on each run of 1375 pieces for this one part is $2,172.50.

Kearney & Trecker hardens a total of 138 different parts on one "TOCCO JR." machine. Output of some parts has been increased as much as 500%.

Output of the saddle clamp eccentric was boosted 144%—from 41 to 100 pieces per hour!

Why not enlist TOCCO's experienced Engineers to help you obtain similar improvements for *your* production? New booklet, "Results with TOCCO", free on request.

THE OHIO CRANKSHAFT COMPANY • Cleveland 1, Ohio

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ANNEALING..HEATING

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SILVER

BRAZING ALLOYS:

"Readyflow"—56% Silver—works at 1165 deg.

B 201 —20% Silver—works at 1485 deg.

Also many other standard and special compositions.

ANODES:

Of all desired dimensions.

FLUXES:

For use with Silver Brazing Alloys.

Write for booklet "MA"

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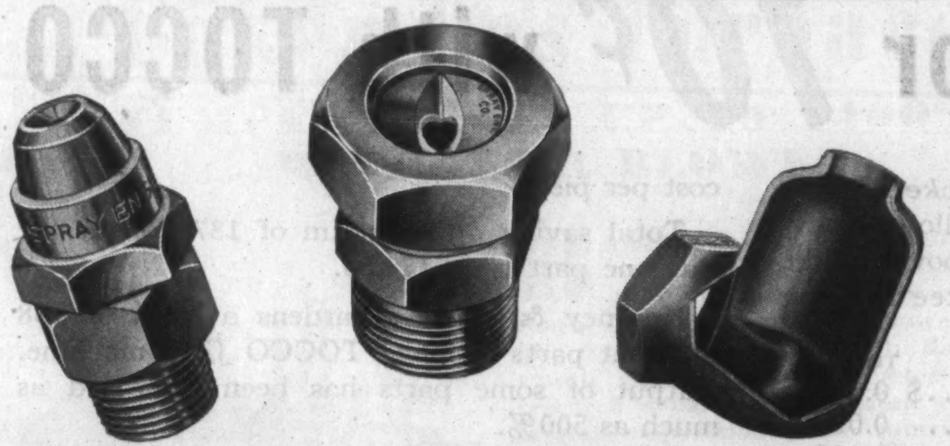
N. J. R. R. AVE. AT OLIVER ST.
Newark, N. J.
EST. 1875



SPRACO NOZZLES

For industrial processes involving washing, cooling, spraying, scrubbing, and quenching, Spraco Nozzles are available in a complete range of types, sizes, and capacities. Standard materials are cast iron, brass, and bronze, but nozzles for use with corrosive liquids and gases can be supplied from any machinable alloy (with suitable priorities).

Write to

SPRAY ENGINEERING CO.
109 CENTRAL STREET SOMERVILLE, MASS.

first comprises troostite, sorbite and pearlite; the second, crystallographic, granular and uniform osmondite; the third, spheroidite; and the fourth, mosaic outline precipitation.

It is evident that the rate of precipitation increases very rapidly with increasing temperature, and also with increasing aluminum content. As to composition, the controlling factor will be the degree of supersaturation existing at the particular precipitation temperature which for any given alloy will decrease with increasing temperature.

Thus, the higher rate of precipitation caused by increasing temperature will be offset to some extent by the accompanying reduction in degree of supersaturation.

Conclusions drawn were: The rate of hardening increases with increased aluminum content; the degree of hardening produced with less than 8% Al is very small.

Regarding the influence of temperature upon the hardening of the alloys containing 8 and 12% Al, it was indicated that: Maximum hardness is obtained by precipitation at the lower temperatures, but longer times are required; the initial rate of hardening is higher at the higher temperatures; for each temperature, after a peak hardness value has been reached, further treatment results in softening, being most marked for the 12% Al and the higher temperatures; the 12% alloy, when heated at 130 C., shows no hardening in the initial stages of heat-treatment.

These results show that it is inadvisable to use the high aluminum alloys for applications where they will be run at temperatures much above 150 C. No detectable increase in hardness was observed in any of the alloys before the production of microscopically visible precipitation, which indicates that the Duralumin type of hardening is not obtained in magnesium alloys.

Tensile Properties

The following facts concerning tensile properties were deduced: The ultimate tensile stress is greatly increased by the much prolonged solution treatment, the ultimate improvement for all precipitation treatments being of the order of 3 tons per in.; prolonged solution treatment causes a slight decrease in the 0.1% proof stress obtained in the precipitated condition.

Increasing precipitation temperature causes reduction in ultimate and proof stresses, with but little corresponding improvement in percentage elongation, which actually seems to pass through a minimum at about 175 C. The drop in properties is not great between 150 and 200 C., but above 200 the ultimate tensile stress falls off rapidly. This coincides with the formation of granular osmondite.

The results obtained show clearly that the best mechanical properties are associated with fine, well-dispersed beta phase. It is interesting to note that the conversion of granular osmondite to a spheroidized structure causes practically no change in tensile properties, though it might have been expected to cause some decrease in proof and ultimate stresses with an increase in elongation.

—F. A. Fox & E. Lardner, *Metal Industry*, Nov. 19, 1943, pp. 322-325; Nov. 26, pp. 340-342; Dec. 3, pp. 363-364.

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110
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Tough and ready "110" can handle these birds. He's got just what it takes to lick both abrasion and shock at once. When he puts on a hard-surface, it's there to stay — and parts stay on the job longer.

This special P&H Alloy Electrode is used for general repair and maintenance when abrasion and shock resistant welds are needed. "110" has a hardness range of from 20 to 40 Rockwell "C" without heat treatment. With flame hardening, its values run as high as 62 Rockwell "C".

Whatever your wartime problems demand, there is a P&H Alloy Electrode ready to serve. The complete line includes all types for hard-surfacing, resistance to wear, impact and abrasion, for welding stainless steels, 4-6% chrome steels, air hardening steels, etc.

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4

Materials and Engineering Design

Engineering Properties of Metals and Alloys • Resistance to Corrosion, Wear, Fatigue, Creep, etc. • Engineering Design Problems of Specific Industries and Products • Selection of Metals, Metal-Forms and Fabricating Methods • Non-Metallics in the Metal Industries • Applications of Individual Materials • Conservation and Substitution

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Post-War Materials Competition

Condensed from "Chemical & Engineering News"

Of the various developments engendered by the war, much emphasis has been placed on the light metals and the synthetic plastics. Much has been heard about the way these newcomers will compete with steel in their effort to support the production facilities that will presently exist. Is this really a menace to the steel industry?

The light metals, aluminum and magnesium, are outstanding examples of enormous *percentage* increases in output. Recent published estimates place the planned capacity of the aluminum industry at 3,000,000,000 lb. per yr. The pre-war output was about 10% of this. Likewise, pre-war magnesium capacity was only about 1% of the planned capacity of about 600,000,000 lb. per yr.

The large war uses of aluminum and magnesium are in airplane construction and in incendiary bombs. Since the latter will disappear with peace and the former will undoubtedly be sharply reduced, new fields of use will be necessary if the plants are to continue to operate at capacity.

The previous capacity figures represent 1,500,000 net tons of aluminum and 300,000 tons of magnesium, or only somewhat less than 2% of the projected yearly steel capacity of 100,000,000 tons. Even on the basis of bulk weight (1 lb. of aluminum has the volume of about 3 lb. of steel and 1 lb. of magnesium about 4.5 lb. steel), the percentage based on steel, even with 100% replacement, is not too alarming. Viewed from this angle, the impact of the light metals on the steel industry can hardly be expected to be as great as the usual effects of the rise and fall of business activity. The steel industry cannot be expected to surrender tamely to light metals, even to the extent of 2%.

Which Industries?

Offhand it might seem easy for the light metals to develop by intensive effort to a tonnage of only 2% of that of steel. Many statements have been published suggesting that the transportation industry could easily absorb it, based on the economy of low weight in such use. Transportation includes airplanes, autos and trains. Airplane use will undoubtedly continue, but the scale will inevitably be far less.

With automobiles, trucks and the railroads, post-war expansion seems reasonable. A goal of an average of 300 lb. of light metal per car or truck would appear optimistically ambitious. Even with a 5,000,000 unit market, this would only take 750,000 tons of light metals, or a little more than one-third of the projected producing capacity.

The railroads have less than 2,000,000 freight and passenger cars in service, according to recent statistics. The replacement demand for equipment can hardly be expected to afford as large a potential use of light metals as the automobile industry.

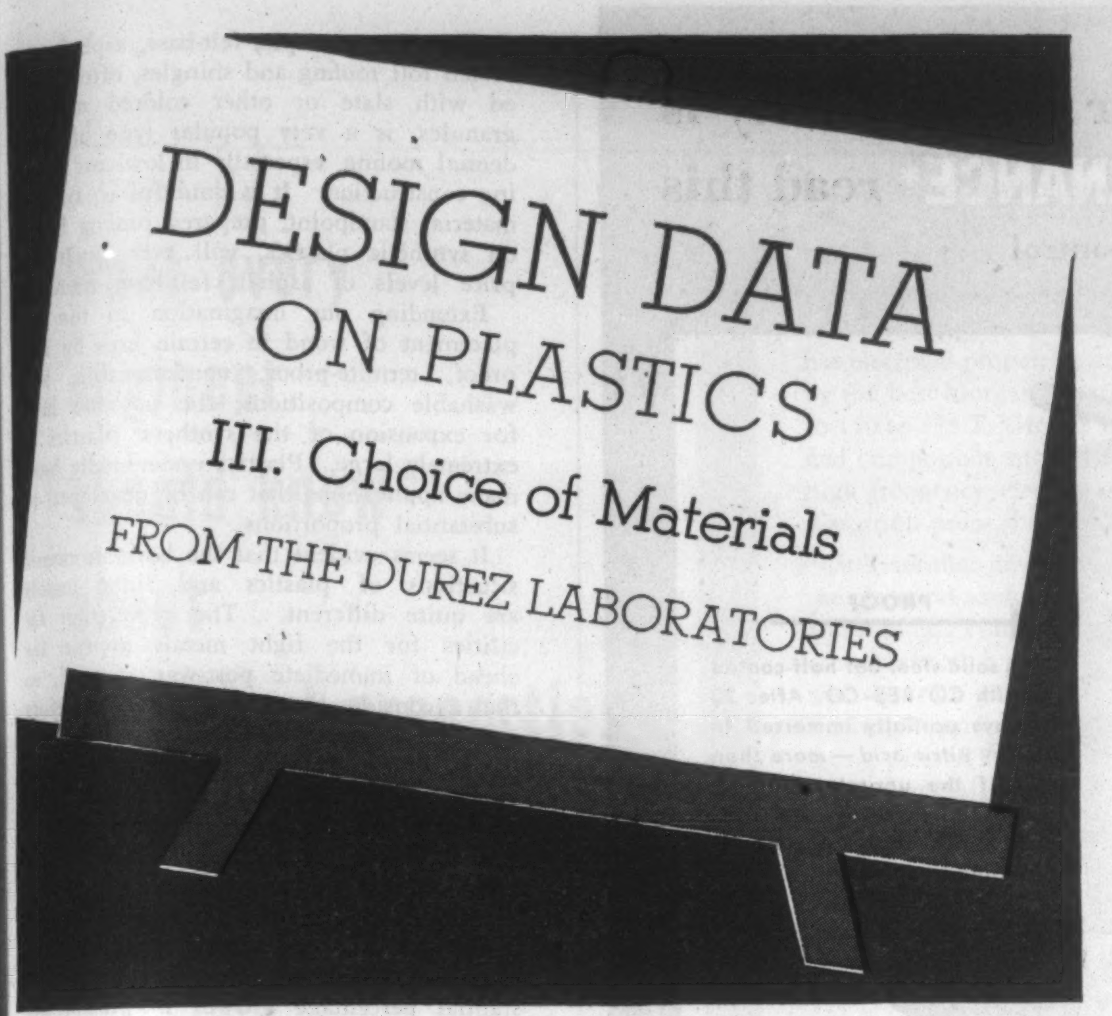
Light metals will therefore have to reach far beyond the transportation field to utilize the available production capacity. They will have to justify their entrance into some broader line, such as building and structures. The road is not easy. Progress appears necessarily slow.

Plastics in the Picture

In all these fields, plastics will also fight for recognition. Exact estimates of production are not available, but a safe top figure of present capacity would be less than 300,000 tons of plastics per yr. Many uses of plastics — notably the protective coating field — are not competitive with the light metals.

In the automobile and truck industry, an average use of 100 lb. of synthetic plastic per unit would aggregate around 250,000 tons per yr., and require the entire production facilities for the type of plastics required. This goal does not appear out of reason when the diversity of properties available in plastics is considered.

The building industry appears to afford a large field for synthetic plastics, even with apparently small items, especially if costs are reduced as a result of tonnage pro-



DESIGN DATA ON PLASTICS

III. Choice of Materials

FROM THE DUREZ LABORATORIES

That a relationship exists between good design and selection of a molding compound, goes without saying. How important the relationship sometimes can be is illustrated by the much-talked

Temperature range from −40° F to +170° F

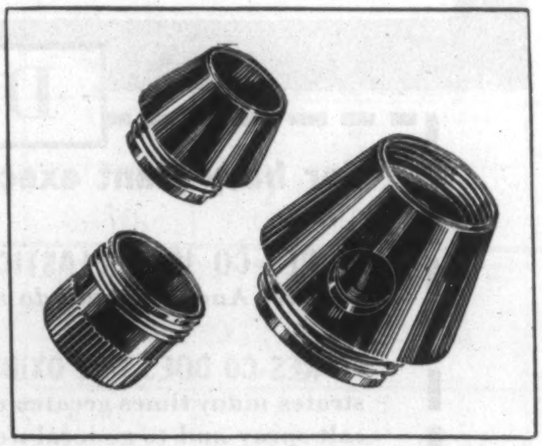
about trench mortar shell fuze, molded with a Durez phenolic.

Saving a sizeable weight of material on each fuze, Durez takes the place of machined aluminum. It was recognized from the first that certain changes in design would be required. Yet, the plastic parts had to be interchangeable with those of metal. This set up definite restrictions in design, of course.

Close tolerances have to be held. There must be a minimum of shrinkage coming out of the mold. But what everyone knew would be a difficult molding operation just had to be made to work. Those were "orders" from the war-front. It was a precision job from start to finish. Furthermore, design and material had to be correlated to service specifications. In temperatures from −40° F to +170° F there must be absolute dimensional stability. Cold flow must be at a minimum. Moisture resistance is essential.

This shell fuze has been a challenging and highly-important plastic project. We are pleased to report the satisfactory performance of a Durez phenolic. More than that, it is an excellent example of the teamwork which goes on within the Plastic Industry . . . among designers, molders and material producers.

Perhaps this same teamwork can be applied profitably to a design you are considering. The versatility of Durez phenolics gives you almost any combination of properties you seek. It may prove to be an important time-saver in your development work.



A precision job from start to finish

We welcome your inquiry and offer the facilities of one of the most experienced technical staffs in Plastics. Durez Plastics & Chemicals, Inc., 93 Walck Road, North Tonawanda, N. Y.

DUREZ

PHENOLIC MOLDING COMPOUNDS AND RESINS

PLASTICS THAT FIT THE JOB

duction. For example, felt-base, asphalt-saturated roll roofing and shingles, often coated with slate or other colored mineral granules, is a very popular type of residential roofing, especially in low-cost housing construction. It is doubtful if, from a material standpoint, prepared roofing based on synthetic plastics, will ever reach the price levels of asphalt felt-base roofings.

Extending our imagination to the replacement of wood in certain uses by rot-proof, termite-proof, nonflammable, and washable compositions, the possible field for expansion of the synthetic plastics is extremely large. Plastics undoubtedly have many applications that can be developed to substantial proportions.

It seems evident that the basic economic situations of plastics and light metals are quite different. The production facilities for the light metals appear far ahead of immediate post-war demand, so that a considerable time will elapse before the gap is filled. Plastics, on the other hand, with the lower tonnage base from which they start, should have an easier task, and after a relatively short period of post-war recession, may be expected to resume their pre-war upward trend.

Neither appears to be a serious menace to the steel industry when comparative tonnages are considered. Nor does a very substantial percentage growth in plastic use seem to be a marked hindrance to light metal development.

—J. M. Weiss. *Chem. & Engrg. News*, Vol. 21, Dec. 10, 1943, pp. 2020-2021.

Electroplated Military Supplies

Condensed from "Proceedings," American Electroplaters' Society

Factors affecting the availability of metals for electroplating are discussed. Very little nickel is now being plated. Cadmium is employed to the limit of its availability on fuse parts and airplane fittings, but even for these critical uses, zinc is being increasingly substituted.

The scarcity of tin has led to extensive use of electrolytic tin plate with much thinner coatings of tin than were customary with hot-dipped plate.

The use of chromium coatings for protecting steel against abrasion and corrosion has greatly increased. Silver plating has many important applications, but its high price and its tendency to accelerate corrosion of any exposed steel impose limitations on its use.

Lead coatings do not usually exert electrolytic protection to steel, but do not accelerate corrosion and any pores are likely to plug with corrosion products, thus limiting further corrosion.

Steel cartridge cases for small arms are being zinc plated and treated by the Cronak process. For artillery ammunition baked organic coatings on steel are apparently satisfactory.

If your responsibility is MAINTENANCE* read this

*corrosion control

SOLID STEEL
10% NITRIC ACID

PROOF

A solid steel bar half-coated with CO-RES-CO. After 20 days partially immersed in 10% *nitric acid* — more than half the unprotected steel was eaten away. The CO-RES-CO coated portion remained *unaffected.*

Data

For busy plant executives and engineers:

CO-RES-CO IS A PLASTIC solution in a hydro-carbon vehicle. And — *plastics do not corrode.*

CO-RES-CO DOES NOT OXIDIZE. It is *not* a paint. It demonstrates many times greater resistance to severe acid, alkali, salt spray and to general weathering than can be expected from any of the oxidizing paints.

CO-RES-CO EMPLOYS NO DRYERS. (To whatever extent dryers are used in the paint film, the paint is weakened exactly to that extent.)

CO-RES-CO IS WIDELY USED. It is an accepted method of corrosion control in many industries and official government departments.

WRITE for further data, giving details of your corrosion and maintenance problems for specific analysis.

CORDO CHEMICAL CORP., Norwalk, Conn.
(Formerly: Corrosion Control Corp.)

CO-RES-CO

THE PLASTIC CORROSION RESISTANT COATING

What every engineer should know about electrical properties of molded plastics

Early in the development of modern plastics they were widely adopted by the electrical industry and have been extensively used ever since for their unique combination of excellent electrical insulating properties and good mechanical strength.

Phenolics of the Resinox type, both molding compounds and laminates, are the most common materials used in this field. They readily meet insulation requirements at power frequencies. Being thermosetting, they have better heat resistance and dimensional stability than thermoplastics.

At high frequencies and under severe voltage gradients, however, some of the newer plastics are more desirable. Lustron, Monsanto's polystyrene, has electrical properties unequalled by any other plastic and rivalled only by the best inorganic materials such as fused quartz. It is heat stable up to 150 to 175°F. Greater resistance to heat has been developed in modified compounds such as Monsanto's Styramic, which has all the superior high frequency electrical characteristics of Lustron plus a higher heat distortion point, better machining qualities and non-inflammability.

Still another new group of materials which promise to enlarge further the electrical usefulness of plastics are the melamine-formaldehyde resins and molding compounds. Unlike most other plastics, they have excellent arc resistance, a property especially desirable in such applications as aircraft ignition parts where high altitude conditions are particularly conducive to arcing with resultant carbonization across the surface of insulating parts. These, like the phenolics, are thermosetting materials with good heat resistance and dimensional stability.

Obviously, these few facts, plus the table below, can give you only a quick, over-all picture of the electrical qualities of Monsanto plastics. Because the family of Monsanto plastics is so large and versatile, however, this amounts practically to an over-all picture of plastics in general. For the same reason, when you want information on a particular problem, you will find Monsanto technical men one of the best possible sources. MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield, Mass.

ELECTRICAL PROPERTIES MOLDED PLASTICS	Water Absorption	Safe Top Operating Temperatures °F	Arc Resistance sec. before carbonization	Dielectric Constant 1 MC	Power Factor 1 MC	Loss Factor 1 MC	Dielectric Strength 60 cycles
Resinox phenolic electrical compounds	0.07	450	1-5	3.4	0.0105	0.0325	400
Resinox phenolic general purpose compounds	0.50-0.60	250	1-5	4-4.5	0.03-0.04	0.12-0.16	295
Melamine mineral-filled compounds	0.10-0.15	300-380	150-160	4-5	0.025-0.035	0.10-0.18	600
Melamine alpha-cellulose-filled compounds	0.45-0.55	210	75-85	5.6	0.042	0.23	350-400
Lustron polystyrene compounds	0.05	150-175	120-135	2.5-2.6	0.0003	0.0008	300-700
Styramic modified polystyrene compounds	0.046	170-190	—	2.68	0.0003	0.0008	—

THE BROAD AND VERSATILE FAMILY OF MONSANTO PLASTICS INCLUDES:

Lustron polystyrenes • Saflex vinyl acetals • Nitron cellulose nitrates • Fibestos cellulose acetates • Opalon cast phenolics Resinox phenolic compounds

Forms in which they are supplied include:

Sheets • Rods • Tubes • Molding Compounds • Castings Industrial Resins • Coating Compounds • Vuepak Rigid, Transparent Packaging Materials

MONSANTO PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

In the Production of Magnesium, Both Amsco Alloy and Amsco Manganese Steel Have Found a Place

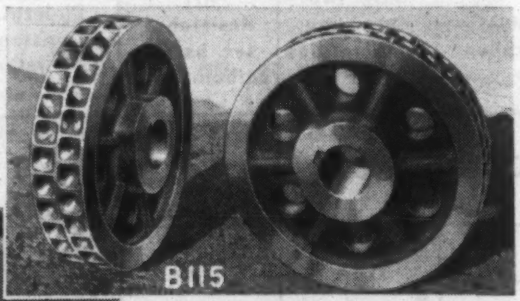
Multiplying by many times America's output of magnesium to meet such needs as lightweight aircraft parts and incendiary bombs has been one of industry's major accomplishments.

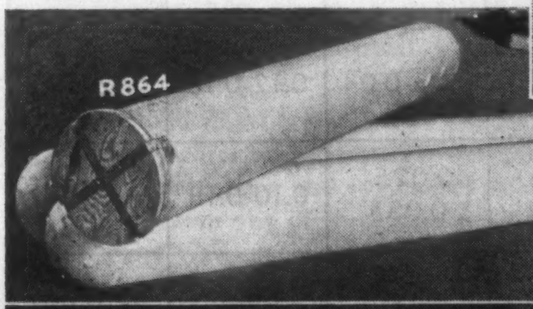
In the Pidgeon process of magnesium production, both Amsco Alloy and Amsco Manganese Steel are used in applications where their respective properties help make continuous operation possible. This process consists of distilling metallic magnesium in the form of vapor from briquettes made of a mixture of ferro-silicon and dolomite under low pressure in a furnace, operating at a temperature of about 2150° F.

There are usually twenty retorts to each furnace, laid side by side. After gases (principally hydrogen) have passed off, the retort is sealed and a vacuum, as nearly perfect as possible, is produced. The retort castings must, therefore, be leakproof. The vapor is condensed by a water jacketed condenser sleeve inserted prior to sealing in the open end of the retort, crystals forming in a dense mass in the sleeve. These crystals, averaging about 15 lbs. per retort at the end of an 8-hour run, are melted and cast into pigs.

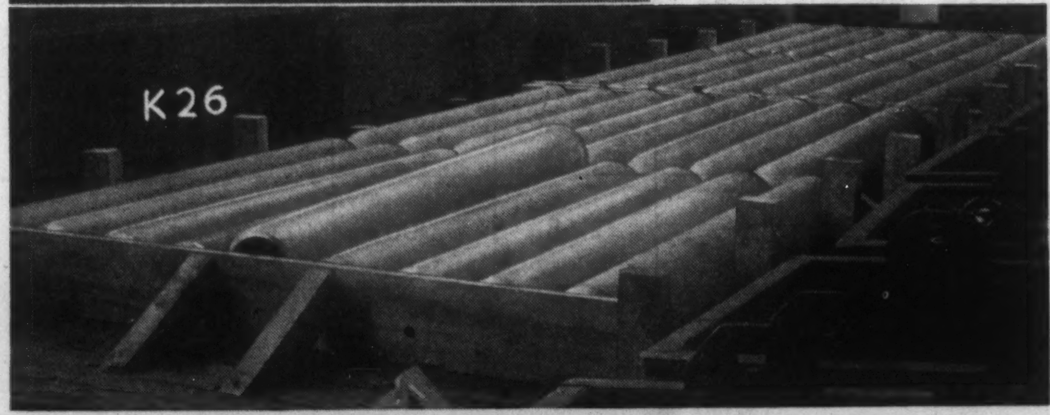
Picture R-864 shows some of the Amsco Alloy retorts employed, and in picture K-26 appears one of the many carloads of these retorts which have been shipped during the past two years to producers of magnesium by the Pidgeon process.

Amsco manganese steel also has a part in the same process, in the form of the pressure rolls shown in picture B-115, used for forming the briquettes of powdered ferro-silicon and dolomite. Here the high resistance of manganese steel to pressure loads and abrasive wear affords maximum service life.


B115


R864

Bulletin 108 describes the uses of Amsco Alloy in all industry; and 1041A deals specifically with heat-treating containers.


K26

Send for Bulletin 941W on Amsco Conservation Welding Rods.

Amsco
AMERICAN MANGANESE STEEL DIVISION
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OFFICES IN PRINCIPAL CITIES

AMERICAN **Brake Shoe** COMPANY

Extensive army camp tests were made of the following coatings on steel tableware during the past year: (a) silver on steel, 0.0005 in. and 0.001 in. thick, applied in a single layer and as a multiple coating with intermediate burnishing; (b) silver over (1) copper, (2) nickel, (3) copper and nickel; (c) chromium on plain steel and on case hardened steel; (d) chromium over (1) copper, (2) nickel, (3) copper and nickel; (e) tin by plating and by hot-dipping; and (f) zinc by plating.

It was found that under the severe conditions involved in the daily washing of this tableware, its useful life was determined more by its resistance to abrasion than to corrosion. The best performance was obtained with (a) 0.0002 in. chromium on case-hardened steel, and (b) 0.00002 in. chromium over copper and nickel.

The finish on the steel appears to affect the protective value of the coatings, especially silver. Porosity tests, such as salt spray and hot water tests, give very misleading results when used to evaluate coatings on tableware and mess trays.

Chromium coatings are likely to be too brittle to give good results on articles subject to deformation, such as canteen cups and mess kits. Zinc is being used as a coating on the latter articles, and though it darkens in use, it is fairly satisfactory.

Acid foods, such as tomato juice, pineapple juice and sauerkraut, should not be allowed to remain in contact with zinc-coated containers longer than is necessary for the consumption of the foods.

—William Blum. *Proc. Am. Electroplaters' Soc.*, June 1943, pp. 3-5.

Steel Wire for Conductors

Condensed from "Power Plant Engineering"

While the use of steel wire for electrical conductors was stimulated by war-created shortages of copper, it was begun many years ago for electrical transmission and distribution circuits. It was natural, therefore, that WPB should request the use of steel conductors.

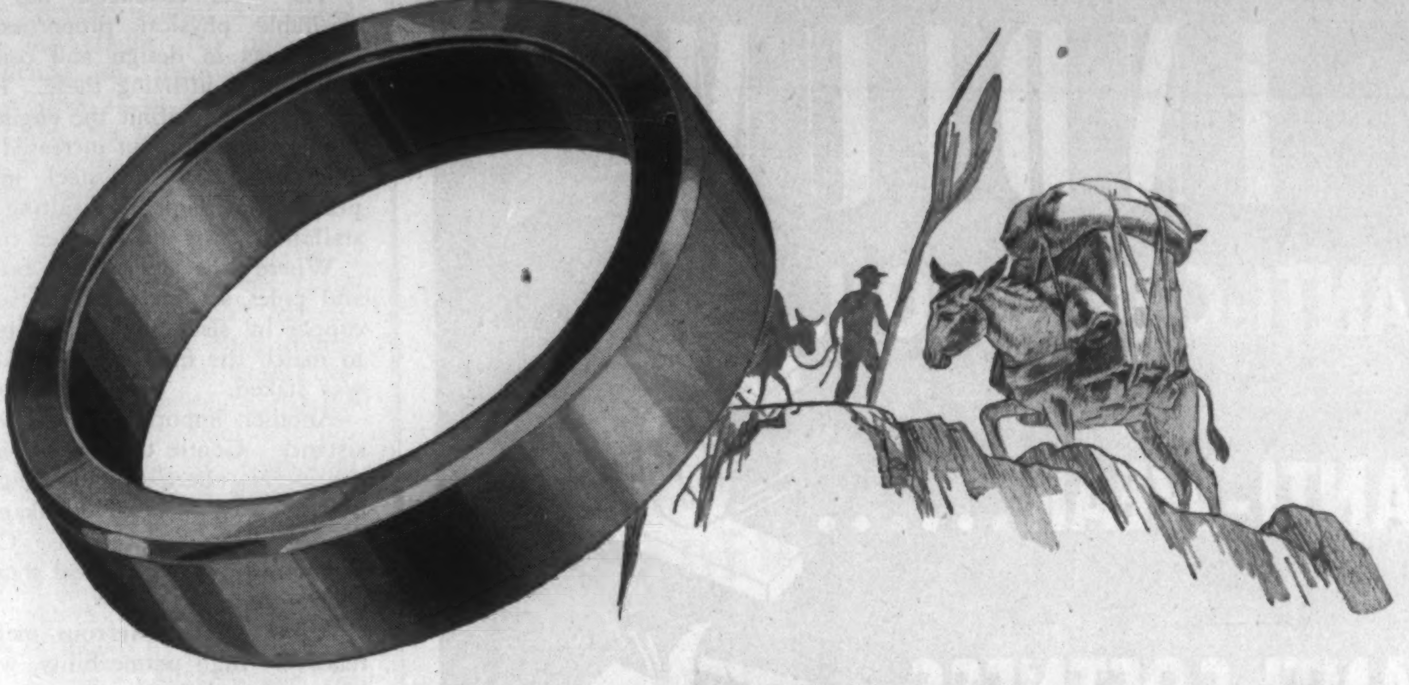
The steel wire is to be bare, with ASTM designation Class A Zinc Coating. A selection of properties is available in the SAE 1020 or SAE 1025 from hard drawn BB to Siemens-Martin Strand.

A special steel made by American Steel & Wire Co. lends itself well to transmission use. It is made in two grades, 3S-130 and 3S-80, the 130 and 80 indicating the tensile strength of the individual strands in thousands of pounds. It is felt that the wishes of the WPB will be fulfilled by the adoption of the 130 grade as the type to fit most conditions.

This galvanized steel, with a flat 60 F. final sag curve, can be matched readily with any other type of conductor. It can be used as an underbuilt neutral, provided

(Continued on page 692)

Pretty Small . . . but it Packs a Lot of Weight



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- √ *Fatigue resistance*
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A non-ferrous alloy, Mallory 1000 metal enables engineers to incorporate great heaviness into a small amount of space. It can be machined to precise tolerances for accuracy in operating at high speeds. It was originally developed to shield the gamma radiation in radium therapy. But now its applications extend not only to gyro-pilot balance wheels, such as you see above, but to flywheels and counter weights—wherever space is at a premium.

Mallory 1000 metal is only one of an amazing group of metals developed by Mallory specialists to answer difficult problems of modern engineering. It includes, as near relatives, Elkaloy*, Elkonite*, and Mallory 3, 53B, 53Z, 73 and 100 metals. Separately or in combination—and together with Mallory "know how"—these metals offer the very characteristics most frequently sought, in modern applications of non-ferrous metals. Descriptive literature available upon request.

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8-IC-2

the line be properly staked for the particular combination.

The steel conductor has exceptionally desirable physical properties, and many economies in design and construction are possible by utilizing these. Higher breaking strengths permit the engineer to obtain longer spans without increased pole heights. The toughness of steel makes it impervious to damage, resulting in lower installation costs than softer conductors.

Where line design has been completed and poles set, steel can be substituted for copper by slacking off the steel conductor to match the final sags for which the line was staked.

Another important factor is fatigue resistance. Gentle transverse winds result in continuous alternating bending of the conductor, and eventual breakage when the fatigue limit is exceeded. Copper has a very low limit, while steel shows very high endurance.

While steel, a ferrous material, has a relatively high permeability, with resulting high internal inductance, the final result is comparatively small. Its internal inductance is 10 to 100 times that for copper, and there is an increase in reactive voltage drop in the line, but internal reactance is only 15 to 20% of the total line impedance, so that even a large increase changes overall performance by a small percentage.

When used for a.c. the steel, being magnetic, introduces some complexing resistance. The main significance of the substitution of steel for copper would be the substitution of larger diameter steel conductors for equivalent copper. Characteristics and size of the higher strength steel conductor tend to minimize the differences in current carrying capacity.

—S. O. Miller. *Power Plant Engrg.*, Vol. 47, Dec. 1943, pp. 103-105.

Aluminum Wool in Brake Linings

Condensed from "Light Metals"

The use of asbestos as a matrix for brake linings was considered practically indispensable due to the great heat frequently generated during operation. Only asbestos combines the flexibility and high heat resistance deemed necessary. However, the coefficient of friction of asbestos is not particularly high.

Tests have demonstrated that a continuous mass of aluminum wool impregnated with rubber is likely to give good results as brake linings. In fact, claims are made that such linings have many properties superior to those of the usual asbestos compounds.

The coefficient of friction of the aluminum wool/rubber brake linings is very high (about 0.4), and is maintained over

(Continued on page 695)

long periods of time when in sliding contact under pressure against a metallic surface (one firm claims that the coefficient of friction of their aluminum wool/rubber product is as high as 0.8). The successful use of a thermoplastic such as rubber under these conditions appears to depend upon the high thermal conductivity of the aluminum wool.

These brake linings have proven satisfactory in normal running and endurance tests in automobiles, commercial motors, railcars and winding engines. Such linings are stated to be used on the brakes attached to the catapult launching apparatus on aircraft carriers; with hydraulically operated brakes lined with the aluminum wool/rubber composition, it is feasible to bring the catapult to rest within nine yards from a speed of 240 miles per hr. The surface heat is largely suppressed by the rapid dissipation of heat throughout the large mass of metal.

The results of tests are given comparing the usual asbestos lining with an aluminum wool synthetic rubber composition. The test conditions were: Sliding speed, 1080 ft. per min.; pressure, 85 p.s.i.; brake drum surface, pearlitic cast iron; set-up run 15 min. before actual tests started, then 30 min. longer.

With the usual asbestos lining, the coefficient of friction decreased from about 0.35 to under 0.2. With the aluminum wool/rubber composition, the coefficient of friction increased from about 0.28 to 0.4 at 10 min., then decreased slowly to 0.35 at 30 min.

There was a gradual increase in temperature up to about 250 C. for the aluminum wool/rubber, and up to about 220 C. for the asbestos. However, the former sustained a wear of only 0.1 cc/hp/hr. as against 0.29 cc/hp/hr. for the asbestos.

The aluminum wool/rubber may be riveted and hammered without fracture. Unlike asbestos types of linings, the braking efficiency is not markedly impaired by grease or oil on the brake drum surface.

—Light Metals, Vol. 6, No. 1943, pp. 536-537.

Design for Copper Brazing

Condensed from
"Sheet Metal Industries"

For copper brazing, the most important requirement that the designer must specify is the fit. Some compromise is necessary between the need for consistent and high strength of the brazed joint and the demand for low production costs. If the gap is large, over 0.003 in., the strength of the brazed joint will not exceed the strength of cast copper, and generally will be less.

On the other hand, a close fit will increase production costs and thereby defeat the purpose. Fits are dependent on (1) diameter of the job; (2) surface fin-

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Worn bearing surfaces on old equipment can be rebuilt quickly and economically by maintenance crews.

Ampco-Trode coated welding electrodes deposit weld metal comparable in strength, ductility, and bearing qualities with the various grades of cast Ampco Metal. This deposit can be applied to the cheaper base metals, giving a more durable finished part at lower cost.

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W-2

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This 2,800,000 lb. stripper, designed and built by Bucyrus-Erie Company, has an automatic leveling mechanism operated by a hydraulic jack at each corner of the base. At one end of each piston in this hydraulic jack, 16 sq. ft. of steel bearing surface is overlaid with Ampco-Trode Grade 18 by metallic-arc welding . . . for maximum wear-resistance.

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Ampco-Trode coated aluminum bronze welding electrodes—for metallic-arc, carbon-arc, or gas welding—are available in five grades. Consult your electrode supplier.

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ish (closer tolerances are necessary for fine ground or lapped parts than for rough ground or turned parts, where the bottoms of the grooves form good capillary paths for the molten metal); (3) compressibility or yield of the parts (a thin pressing will yield slightly and increase the interference, while a solid pin in a hole will not yield and will require sizes tight enough to hold and slack enough to press in without seizure).

Design of Joint

To increase the strength of the joint in a thin pressing, one way is to leave adequate shoulders on the plug component to get additional brazing area. Special care must be taken to ensure that all burrs are removed from the edges of holes, but the corner must not be chamfered so that the gap is too great to permit the copper to run.

If a large interference fit is obtained, trouble will probably be experienced due to the edges of the hole scoring the surface of the spindle and pushing a burr up between itself and the shoulder so that good contact is not obtained. This may result in a gap of such size that the copper will not run.

On small parts with spindles of ½ in. or under, a useful way of getting over the question of close tolerances is by knurling. Even with a big interference, a brazed joint may be obtained that is sufficiently good for many purposes, as the channels of the knurl leave room for the copper to flow and wet the joint.

This device is also useful in brazing nickel or nickel alloys, as the copper is soluble in nickel and does not readily flow into a tight joint.

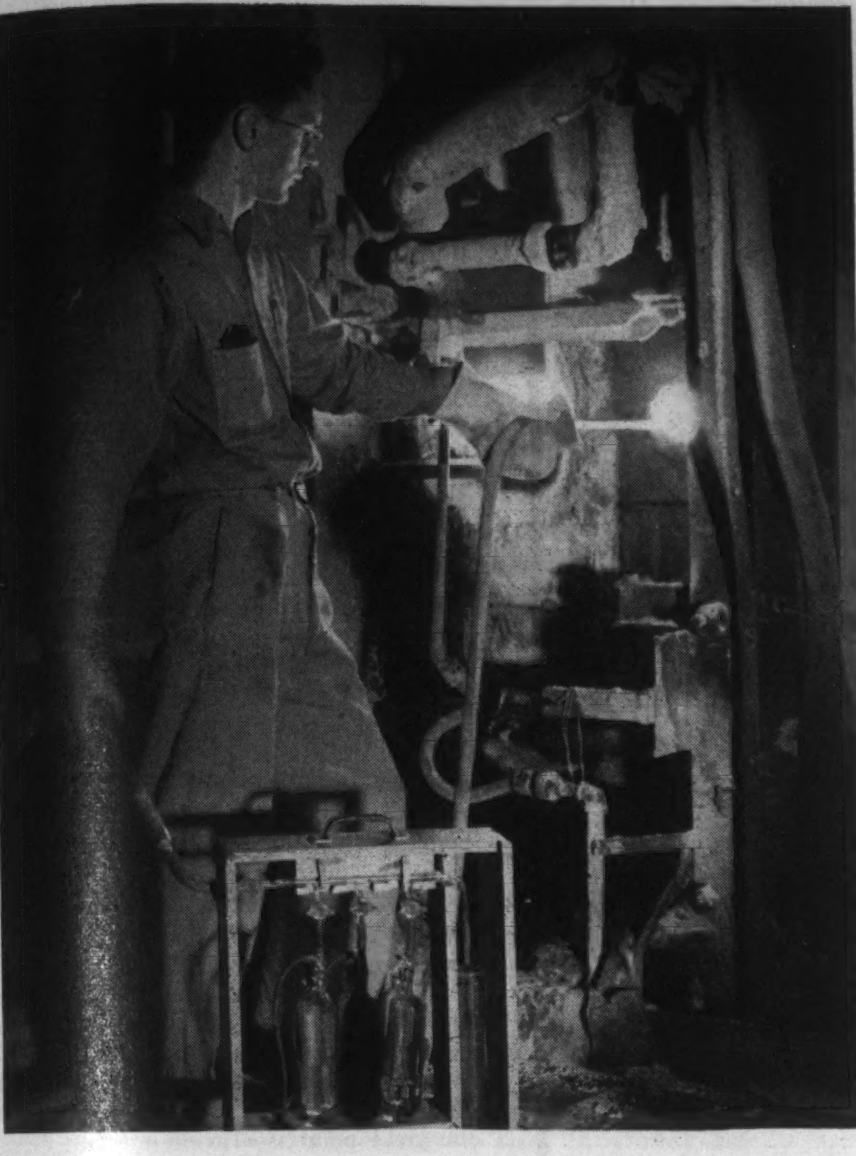
Small spot welds have been used in some cases to weld the parts together in their correct alignment before brazing. Brazing jigs can seldom be used (although nichrome and 18-8 have a limited field of application), as they do not retain their size or shape in the furnace and become brittle and distorted.

The brazing atmosphere invariably causes a certain amount of surface decarburization, which can be prevented by coating the surface of parts that require to be case hardened and higher carbon steel parts with a thin copper plate. However, this makes more difficult the check on efficient copper brazing which is given by visual inspection of the brazed parts to determine whether the copper has flowed through the joint.

Steels may suffer a decrease in tensile strength, ductility, and/or impact strength due to the coarsening of the grain structure. A suitable normalizing or heat treatment after brazing restores these properties.

Some high alloy steels, especially high chromium, have been found difficult to braze. Copper plating facilitates brazing in these cases. If considerable difficulty is found, brazing may be more successfully accomplished in an atmosphere of cracked ammonia rather than burned city gas.

—R. F. Tylecote. *Sheet Metal Inds.*, Vol. 18, Oct. 1943, pp. 1789-1791.



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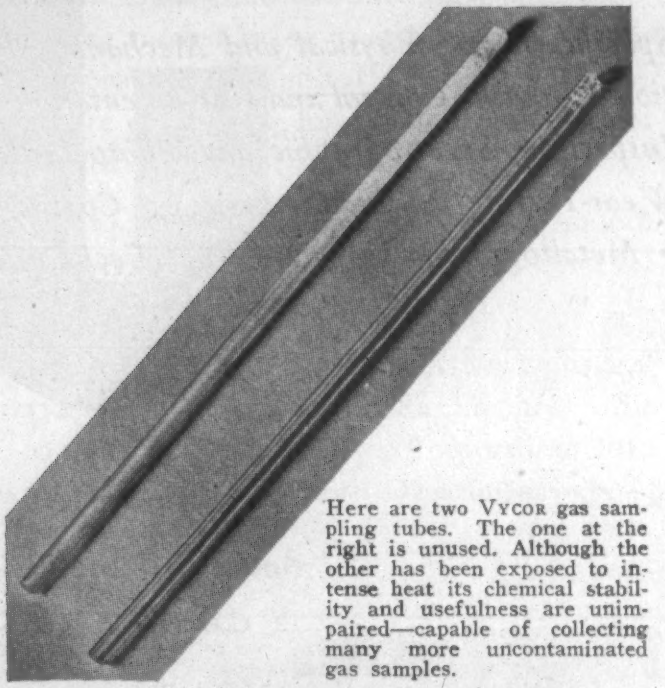

Here are two Vycor gas sampling tubes. The one at the right is unused. Although the other has been exposed to intense heat its chemical stability and usefulness are unimpaired—capable of collecting many more uncontaminated gas samples.

The sampling of hot gases have always been a problem to engineers. When hot gases are drawn through metal tubes, contamination may occur, or the metal may absorb part of the gas. The unrepresentative sample makes the analysis worthless.

Vycor Glassware has proved ideal for gas sampling tubes. They are made from 96% Silica Glass No. 790, which has a remarkably high resistance to thermal shock and is chemically stable. Hot gases do not absorb any foreign substance when collected in non-porous, chemically inert Vycor tubes. The hot gas reaches the cool zone with its original composition unchanged.

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The Vycor gas sampling tube is just one example of solving material problems where high temperatures are encountered.

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Carbide Formers and Yield Point

Condensed from "Archiv Eisenhüttenwesen"

Abundant literature is available to show that the presence of a (lower) yield point in steel under standard tensile test conditions is really dependent on the properties of the material, and is not merely simulated by the test conditions. The aim of the present work was the determination of the influence of carbide formers (molybdenum, titanium, vanadium, chromium) on the yield point of mild carbon steel.

Four series of steels were made up with about 0.05, 0.1, 0.2 and 0.3% C and up to 2.5% Ti or V, respectively. After furnace cooling from 1706 F, all those samples had a well defined yield point which, in addition to titanium or vanadium carbides, contained a proportion of iron carbide corresponding to their position in the Fe-Ti-C or Fe-V-C fields of the constitutional diagrams.

Steels that contained alpha iron with only titanium or vanadium carbide showed a regular stress-strain curve with no yield point. The dividing line between steels with and without a definite yield point appears to be at a ratio of Ti:C = 4:1 for titanium and V:C = 5.7:1 for vanadium steels.

The change from one type of curve to another is very abrupt, indicating that even traces of suitably distributed iron carbide are capable of producing a definite yield point. The variation in stress at the yield point is also of interest.

In titanium steels the yield point is practically independent of the alloy content over the field of the constitutional diagram in which iron carbide is present; with progressive diminution of the iron carbide content to the vanishing point, the yield point falls fairly rapidly.

The vanadium series shows a similar drop, but the yield point appears to rise slightly over the third field of the constitutional diagram with rising vanadium content. In the purely ferritic regions with high titanium or vanadium content, the yield point again rises slightly.

Effect of Chromium

To investigate the effect of chromium, three series were prepared with about 0.05, 0.1 and 0.2% C, and up to 5% Cr. The Fe-Cr-C diagram in this range has four fields: (1) pure alpha iron; (2) alpha iron + iron carbide, which increasingly absorbs chromium in solution as the percentage of the latter increases; (3) alpha iron, iron carbide with chromium in solution and chromium carbide (Cr_7C_3) with iron in solution; and (4) alpha iron + chromium carbide (Cr_7C_3).

After furnace cooling from 1706 F., the steels in field (2) have a definite yield point, which becomes less well defined as the carbon and chromium increase. Chromium steel with 0.2% C in field (3) shows a yield point, while the other steels in this field do not.

None of the tested steels in field (4) showed a definite yield point. The absence of an abrupt change is obviously as-

(Continued on page 702)

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X-ray examination can assure improved welds and castings—castings that will measure up to the high standards demanded in war time production, welds that will withstand severe shock and stress. For with x-ray, it is possible to "see inside"—to examine the interior structure and not only find hidden faults, but study their location and character so that they may be avoided in the future.

Yes, x-ray has found many wartime jobs in industry, and G-E X-Ray units—with transformers, tubes, controls, and mountings all designed expressly for industrial service—are doing the great majority of those jobs.

An ideal unit for use on castings and weld work where widely varying radiographic positions require frequent changes in the vertical height of the x-ray tube head is the G-E Motor-Operated Jib Crane Unit with either G-E Model OX-200 (200,000-volt) or G-E OX-250 (250,000-volt) x-ray apparatus. Its wide range of vertical and horizontal travel and the degree of angulation and rotation of the tube head makes positioning an easy accurate procedure.

Also available with the OX-200 or the OX-250 is the G-E Mobile Jib Crane Unit. Mounted on a pneumatic-tires chassis it can be moved easily to any large inspection job. This unit also provides an unusual degree of flexibility and permits fast, exact positioning for practically all types of radiographic inspection.

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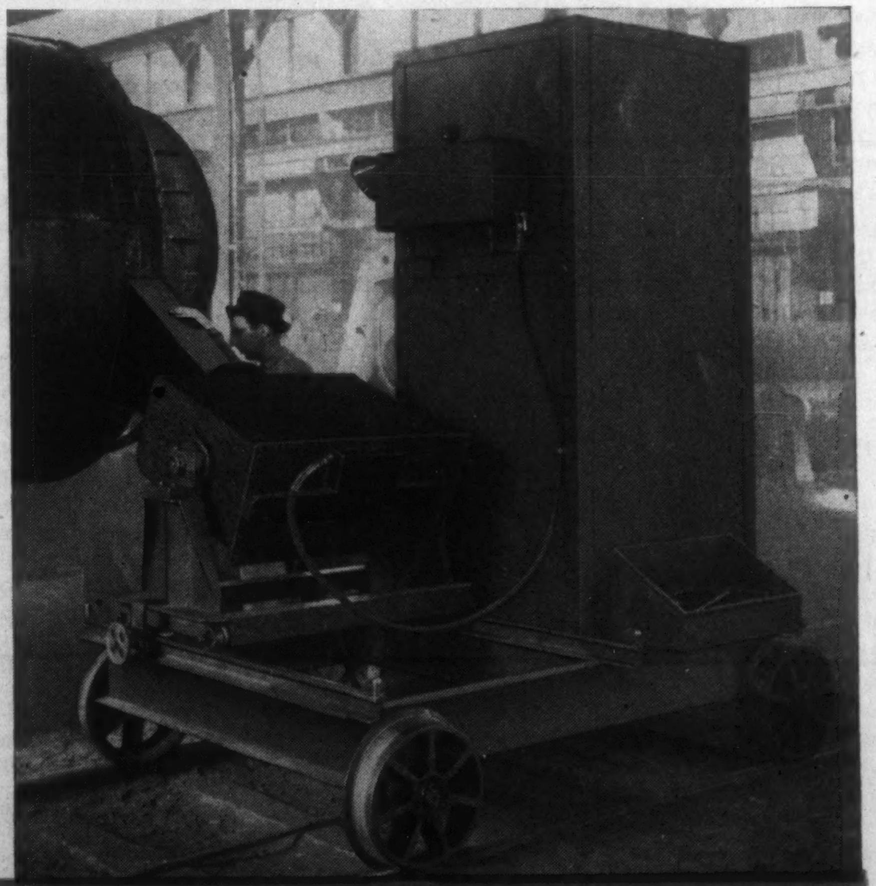

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Although principally designed to provide an inexpensive unit for quick and convenient drying of electrodes in connection with the determination of lead as lead dioxide, this infra red drying oven has a wide variety of other applications. For example, it is excellently suited for such operations as evaporating, drying precipitates, paraffin melting, drying solids, etc. Drying efficiency is well illustrated by the fact that lead dioxide is thoroughly dried in one to two minutes.

The oven consists of a cylindrical case containing a General Electric R-40, 250 watt drying lamp with self reflector, a hinged, chromium plated, hemispherical dome, a chromium plated perforated shelf and an on-off switch mounted on the case. The reflector contained within the drying lamp reflects the radiant heat upward thus directing all energy to the working area of the oven. Further concentration of heat is accomplished by the chromium plated dome which acts as a highly effective heat reflector so reducing to a minimum heat loss by radiation. By means of this design a maximum temperature of approximately 500° F is developed within ten minutes. The fast upward flow of air induced by the open bottom and vent in dome also contributes greatly to the high drying rate of this oven. Average service life of the infra red drying lamps is 5000 hours.

Overall dimensions: height, 13½ inches; diameter, 6½ inches. Inside dimensions: height from top of perforated shelf to top of dome, 5¼ inches; diameter, 5⅞ inches. Electrodes having a total height exceeding 5¼ inches can be placed in the oven by permitting the electrode stems to project out of the vent hole in the dome.

S-64050 Sargent Infra Red Drying Oven—Complete with General Electric R-40, 250 watt drying lamp, perforated shelf and cord and plug. For operation from standard 115 volt A.C. or D.C. circuits....................**$18.00**

S-44200 Infra Red Drying Lamp only, with Self Reflector, General Electric R-40, 250 watt. Each....................**$1.75**

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sociated with an increasing absorption of chromium by the iron carbide. The tests do not indicate any effect of the iron alloy carbide on the yield point.

The influence of molybdenum was examined on a series with 0.5 C and up to 3.3% Mo, air-cooled from 1706 F. The yield point falls with rising alloy and disappears entirely at 1.76 to 3.3% Mo. The effect of molybdenum on the yield point is therefore produced by its increasing absorption on the iron carbide.

Special tests were further made on the titanium and vanadium steels to determine the effect of varying heat treatment on the development of the yield point. There is no effect of cooling rate from 1706 F. on the titanium steels, except that some of the "borderline" steels (*i.e.* on the dividing line of the constitutional diagram), having no definite yield point after furnace cooling, develop a yield range after air cooling.

The development of the yield point in general only begins to vary from that corresponding to furnace cooling from 1706 F. if the material is cooled in air from 2010 F. or more. However, steels corresponding to field four of the Fe-Ti-C diagram still do not show a yield point.

In the case of vanadium steels, air cooling from 1706 F. produces a parallel displacement of the dividing line between the areas with different yield points, indicating that within a certain alloying range and with air cooling from 1706 F., vanadium carbide also affects the development of the yield point. No displacement of the dividing line has been observed in furnace and air cooling from 2010 F.

Further Tests

Further tests were made to determine the effect of precipitated vanadium carbide. Four steels (0.04 C, 0.47% V; 0.04 C, 0.63% V; 0.29 C, 1.95% V; and 0.19 C, 1.64% V) were subjected to various heat treatments with air or oil quenching. Steel with 0.04 C and 0.47 to 0.63% V showed no yield point after oil quenching from 1830 F.; tempering at 1110 F. produced a yield point that disappeared when the tempering temperature was increased to 1290 F.

When the quenching was from 2010 F., no yield point was observed after tempering at 930 to 1290 F., although it reappeared after tempering at 1470 F. The other two steels had regular stress strain curves with no yield point after heat treating at any temperature up to 1470 F.

Bars of the steel with 0.04 C, 0.47% V were treated to give a sub-critical (1830 F. oil quench), critical (1830 F., oil quench + 1 hr. 1110 F.), and hyper-critical (1830 F., oil quench + 1 hr. 1290 F.) grain structure. They were then subjected to a tensile stress (magnitude not indicated) at 930 F. for 45 hr.

This subsequent treatment converted the sub-critical structure into the critical, and the critical into the hyper-critical, while the latter did not change. Obviously, the yield point is governed less by the chemical nature of the precipitated particles than by the form of their dispersion in the material.

(Continued on page 707)

A theory is offered for the development of a yield point. The presence of a definite yield point is considered to be due to the prevention of intra- or inter-crystalline slip. The prevention of slip causing unsteady stress concentration at the yield point is due to the precipitation of certain constituents dispersed through the material in a certain critical way.

Alloying elements in solid solution produce steady elongation curves with a high yield point. A definite yield range appears first when the precipitation from the supersaturated solid solution as a consequence of slow cooling or tempering takes place in a critical form of dispersion.

Such precipitation occurs at discontinuities in the crystal structure, *viz.*, the grain boundaries, and prevents intra- and intercrystalline slip. This theory is also capable of explaining the importance of grain boundaries in the development of the yield point in steel, since precipitated particles tend to accumulate at the grain boundaries.

—K. Dies, *Arch. Eisenhüttenw.* Vol. 16, Mar. 1943, pp. 333-340; translated by L. J. Goodlet, R. T. P. translation No. 1972, *Sheet Metal Inds.*, Vol. 18, Nov. 1943, pp. 1907-1909; Dec., pp. 2079-2086.

Strain-Aging of Killed Steel

Condensed from "Metallurgia"

Strain-aging frequently leads to difficulties in pressing components from sheet or strip, especially under normal production conditions when some time may elapse between rolling of the sheet and its use in the press shop. To overcome these difficulties, so-called non-aging steel has been made by the use of aluminum, but the product has not always been entirely satisfactory.

Many investigations have been made to determine the causes of strain-aging. A recent contribution to this problem is the effect of titanium on the strain-aging of killed low-carbon steel.

Methods of testing for susceptibility to strain-aging were: (1) Automatic plotting of the load deformation diagram of a tension test, with specimen strained and then tested after a period of aging; elongation of yield-point as an indication of amount of aging.

(2) Determining the stress required for 5% strain, and after aging determining the yield. The amount by which the latter exceeds the former is a measure of aging; (3) determining Izod impact resistance of specimen in tension 5%, after straining and after aging. Decrease is evidence of strain-aging.

(4) Work-brittleness test, involving Izod impact test of the specimen strained by cold and drawing; (5) measuring Rockwell hardness of Brinell impressions, before and after aging. The increase in hardness is a measure of aging; and (6) damping records of specimens strained 4% in tension, after straining.

Steels used analyzed 0.022 to 0.135 C, 0.16 to 0.56 Mn, 0.002 to 0.00023 Si, 0.003 to 0.0196 N, about 0.015 P, 0.035 S

(Continued on page 710)

An Important Message to

Technical Men

The war has carried the engineering age to a new peak! Production demands have created technical problems the like of which the world has never seen before! The services of engineers are at a premium. Especially the services of one particular class—executive engineers—*engineers with business training;* engineers who can "run the show."

In these critical times, the nation needs engineers of executive ability *now, today*—not five, or ten years from now! The shortage of such men is acute—even more acute than that of skilled production workers. And company heads, aware of this situation, are offering high rewards to engineers who have the necessary training in industrial management.

Golden Opportunity for Engineers

In this new era, the engineer with vision and foresight has a golden opportunity. He will realize that out of today's tremendous production battles will emerge technical men who not only will play a major role in winning the war, but who also will be firmly entrenched in key executive positions when peace comes.

However, before the engineer can take over executive responsibilities, he must acquire knowledge of the other divisions of business—of marketing, accounting and finance. He has of necessity a vast amount of technical training and experience. But in order to grasp the opportunities that present themselves today—to assume leadership on the production front—he must *also* have an understanding of practical business principles and methods.

The Alexander Hamilton Institute's intensive executive training can give you this essential business training to supplement your technical skill. It is a time-saving program that fits into the most crowded schedule. It is not intended for men who expect to remain just engineers for the rest of their lives. It is for those willing to train for the position that now seems just a little beyond them—the position which will increase their incomes today and make their security more certain when the war has ended.

134,000 men on the operating side of business have enrolled for this training. More than 37,500 are technical men—engineers, chemists, metallurgists—many of whom are today heads of our huge war industries.

This training appeals to engineers because it gives them access to the thinking and experience of the country's great business minds. It is especially valuable to such men because it is basic, not specialized—broad in scope, providing a thorough groundwork in the fundamentals underlying *all* business. It covers the principles that every top executive must understand. It applies to all types of industrial organizations, because all types of organizations are based on these same fundamentals.

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The Institute's training plan has the endorsement of leading industrialists and business men. And it is only because these high-ranking executives recognize its value and give their cooperation that such a plan is possible. Among those who contribute to the Course are such men as Frederick W. Pickard, Vice President and Director, E. I. DuPont de Nemours & Co.; Thomas J. Watson, President, International Business Machines Corp.; James D. Mooney, President, General Motors Overseas Corp.; Clifton Slusser, Vice President, Goodyear Tire and Rubber Co. and Colby M. Chester, Chairman of the Board, General Foods Corp.

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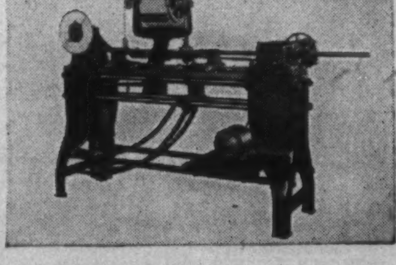

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and up to 0.705% Ti. Titanium was added in the form of 40% low-carbon ferro-titanium with 7% Al.

Results show that aluminum-treated steels had a well-marked yield-point, whether normalized or annealed, in the strained condition after aging 3 weeks at room temperature or for 1 hr. at 440 F. Thus, aluminum was found effective in eliminating strain-aging.

In higher carbon steels the yield-point was less marked when deoxidized with aluminum. Damping capacity tests reveal a slight effect of the same nature. Hardness and impact tests reveal less aging.

In killed steels nitrogen has no effect on strain-aging. This indicates that deoxidation has more influence on strain-aging than nitrogen.

Test Results

To check the claim as to the usefulness of small titanium content in non-aging steel, results seem to support this statement in a limited fashion. Despite many attempts, the steel could not be duplicated to show similar low-aging characteristics.

Results of tests show definitely that only high-titanium steels with titanium-carbon ratio above 4.5 exhibited no yield-point elongation after straining and aging, and this is true for steels whether normalized or annealed, and irrespective of aluminum addition or nitrogen content.

Damping tests also showed these steels to be low-aging in comparison to low-titanium steels. These characteristics were evidently governed by titanium-carbon ratio, and whether the ratio was very low or just below 4.5 made little difference.

Ferrite grain sizes of specimens were determined to throw light on the variations in impact results, and all the high titanium steels were found to be coarser grained. Their impact values could not be correlated with grain size.

Further tests were conducted to determine whether titanium above 4.5 times the carbon content would not eliminate the yield-point of steel even if it were not heat treated or strained, and if the carbon content were somewhat higher than in the titanium steels tested so far; also, the effect of soaking the ingots at a high temperature on the yield-point and aging properties of high-titanium steels.

Results of investigation showed that with at least 4.5 times as much titanium as carbon, steels with less than 0.045% C or with 0.12 to 0.135% C, have yield-strengths higher than similar steels without titanium, and also have better ductility. Furthermore, high titanium steels do not have a distinct yield-point whether in the as-forged, normalized or aged condition.

Therefore, the absence of change in the character of their yield-points on aging after straining cannot be used as evidence of non-aging qualities. Data, however, throw some light on the aging of these steels by showing the increase in stress value between straining 5% and the yield strength after straining and aging.

All of the evidence so far acquired has been derived from bars or rods on a small laboratory scale.

—*Metallurgia*, Vol. 28, Sept. 1943, pp. 239-246.

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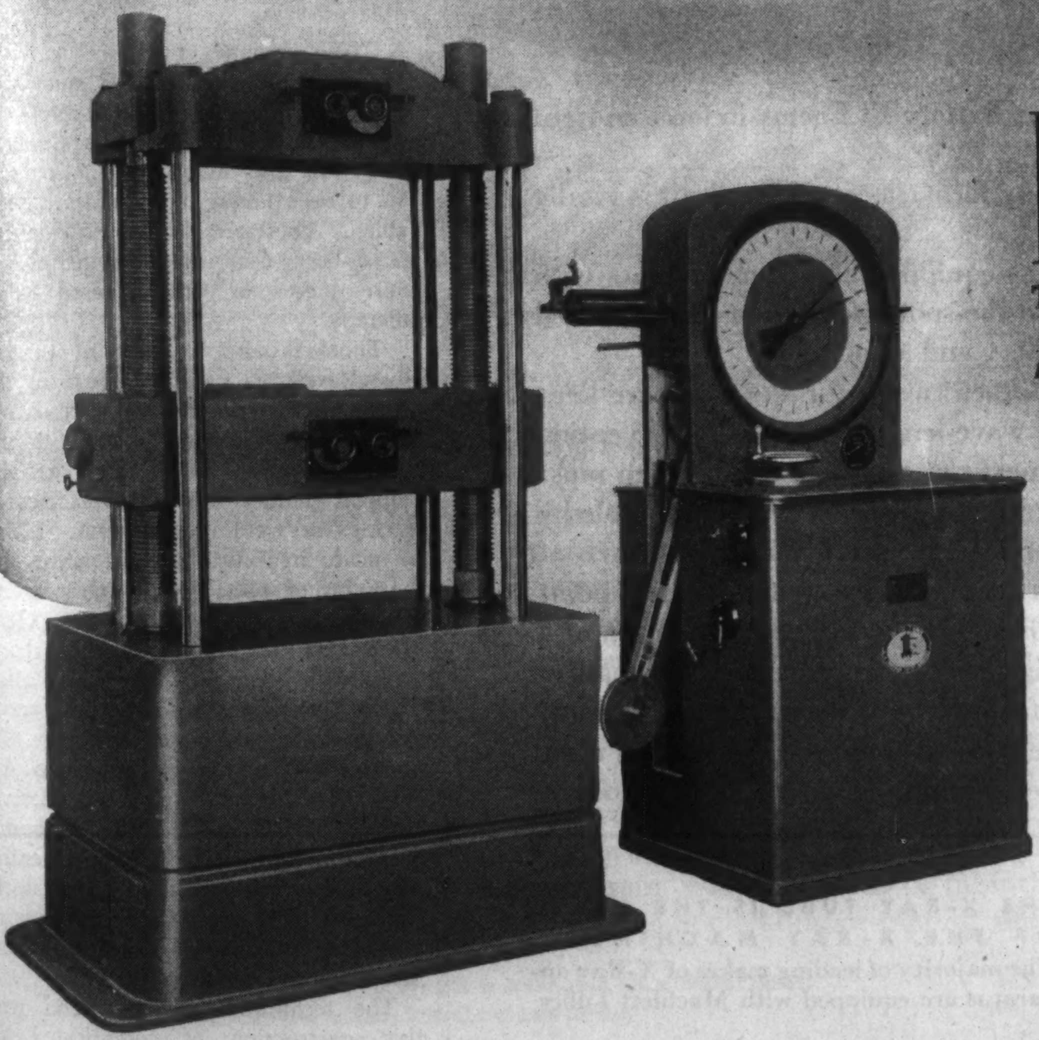

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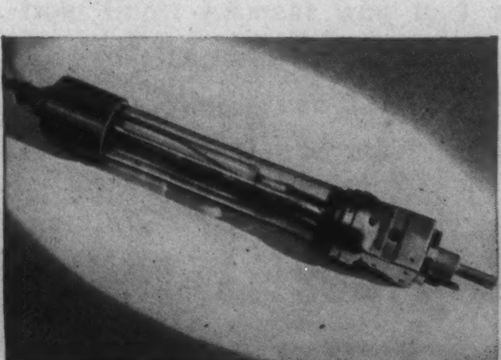
After the war, similar applications of x-ray techniques will point the way to many new and improved processes in the production of a wide variety of products. Savings in cost, improvement in quality, elimination of the "ignorance factor" from design considerations, will give every advantage to the industrial enterprise which is alert enough to utilize the remarkable possibilities of this tool of modern science.



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Radium Screening Materials

Condensed from "Metal Industry"

The increasing use of radium for the radiographic examination of material revives the question of the most suitable materials to be used for the screening of the gamma rays, not only during its use, but during its transportation from one inspection site to another.

The absorption by metals of the gamma rays is proportional to the density of the screening metal. Lead is probably the ideal material. It can be cast easily and machined. It is ductile and cheap.

However, there are at least 15 metals with twice the density of lead, and their use as screens reduces the overall dimension of the unit while giving the same protection. Some are extremely rare and many, even if available in massive form, would be ruled out by their cost.

Therefore, for economic reasons, the choice has fallen on tungsten as a possible substitute for lead.

Tungsten is available, but its theoretical density is developed only after considerable mechanical work has been done on it. The technique for this used on small section bars or rods is not applicable to massive pieces. Attention thus has been given to tungsten alloys or agglomerates.

Heavy Alloys

The technique of producing high tungsten alloys by pressing and sintering mixed metal powders has been developed in the research laboratories of the General Electric Co., and alloys with densities from 10 to over 17 are more commercially available. They are readily machinable, and have been used quite extensively for the nose pieces or nozzles used in radium therapy.

There is also a range of tungsten alloys developed mainly for use in the electrical industry where the arc-resisting properties of tungsten combined with the high conductivity of metals, such as silver or copper, render them valuable as contact facings or welding electrodes. This range is made by filling the interstices between particles of pressed tungsten powder with a metal of lower melting point. Generally, their densities, though higher than lead, are lower than for the heavy alloys referred to above, so they have not been used as screening materials.

H. F. Kaiser, in METALS AND ALLOYS, Vol. 14, Aug. 1941, p. 170, described a different technique in the development of a radium container consisting essentially of tungsten. He used a spherical steel shell packed as full as possible with scrap tungsten rod and sheet. The interstices were filled with mercury or lead.

The technique does not lend itself to the construction of complicated shapes, such as nozzles, but this particular tungsten aggregate was developed for use as a container to transport radium.

Some of the advantages that have led to the adoption of these alloys in radium beam therapy are equally applicable in other branches of radiography, and the demand for screening materials denser than lead is likely to increase.

—G. H. S. Price, *Metal Industry,* Vol. 63, Nov. 26, 1943, pp. 338-339.

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The Cyclograph also grades pieces according to case depth, depth of decarburization, amount of cold working, brittleness, structure, size, heat treatment, wall thickness of tubing, thickness of cladding or plating, etc.

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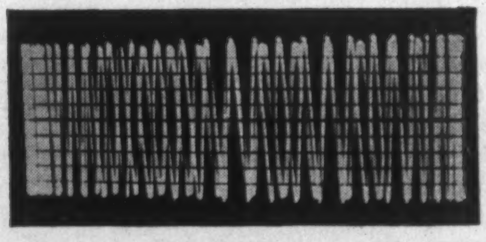

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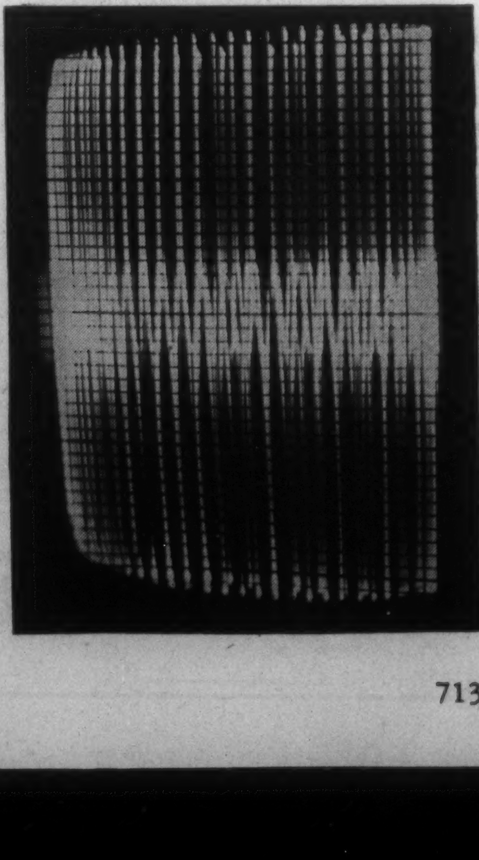


books

FOR METALLURGICAL ENGINEERS

Steel In India

A Steel Man in India. *By John L. Keenan. Published by Duell, Sloan & Pearce, Inc., New York, 1943. Cloth, 5¾ x 8¼ in., 224 pages. Price $2.50.*

The author, a Yale man with a classical education, became a blast furnace operator at Gary. Soon after the opening of the Tata works in India, he went there to run the blast furnaces, later becoming general manager of the whole works. His service at Tata covered 25 yrs. Written in the first person, this is, however, not an autobiography; it recounts accomplishments of his associates rather than his own. Neither is it, save very incidentally, a technical record of the Tata operations. It actually is an appraisal of the people who made those operations possible, the Indian businessmen who financed them, the imported experts from all of the main steel-making countries, and especially the Indian workmen.

His Latin and Greek enabled him to pick up the different languages spoken. He was vastly interested in people and he liked all likeable people All of the races of India were likeable, but this did not extend to the German experts. Some individual high-hat Britishers he disliked as thoroughly as he liked the more representative type.

The ability of the Indian races to become capable technicians, despite no hereditary tendency towards technology, impressed him very strongly. Based on the Tata experience, he visualizes an industrial India, utilizing her own resources, and, after introductory periods analogous to that of the foreign experts used at Tata, her own man power, in supervisory as well as subordinate capacities.

A steel plant operator isn't likely to mince words. Keenan says what he thinks. The background to the "Indian problem," spread by his account, is doubtless more truly drawn than those afforded by many "experts on foreign affairs" who write about that problem. Thus, this record of 25 yrs. in close cooperation with the Indian people is a document worthy of attention by diplomats, politicians, and businessmen. Fortunately, it is so written that anyone who starts it will read it through. The writing was done "with the collaboration of Leonore Sorsby," but she has not altered the masculine quality of the narrative. The book will please the general reader.

Metal industries readers will find it especially interesting, not for technical information, but because of the part played in the design and operation of the Tata mills by stalwarts in the technical development of U. S. steel plants, such as C. P. Perin, Julian Kennedy, etc., and for little metallurgical touches here and there.

The toughest time at Tata was in the rush for production in World War I, before the plant had really shaken down. Absenteeism and week-end hangovers were a major problem solved by putting in a race track, establishment of racing stables, and using the watching of the races and the bettings on them as a safety valve. The race track is now the site of an aviation training school in World War II.

Indian raw materials and manufactured products are a vital contribution to World War II, a contribution of size and quality that the most fantastic dreamer would not have prophesied 25 yrs. ago, in the then undeveloped state of Indian industry. Much of this development has come about because of the existence, growth, and success of the Tata works themselves.

Keenan's account of this period of growth is better and truer history than one finds in the usual history books.

—H. W. Gillett

Steel in Action

Steel in Action. *By Charles M. Parker. Published by the Jaques Cattell Press, Lancaster, Pa., 1943. Cloth, 5½ x 7¾ in., 221 pages. Price $2.50.*

Written by an engineer working for the American Iron and Steel Institute, but designed primarily for the non-technical reader, this little book covers a lot of ground. The history of steelmaking, outlines of the processes used, description of carbon and alloy steels, the sources and economic control of raw materials, the use of scrap, world distribution of producing capacity, American war-time expansion, distribution of steel products, discussion of N.E. steels, and a guess at the status of steel in the postwar world, follow each other at breath-taking pace.

Condensing so much into so little space makes the treatment rather difficult. Nevertheless, the statements are 99 44/100% accurate and intelligible to the non-technical reader.

It's a good job of popular presentation. The cold logic of Parker's discussion of sponge iron, pp. 199-200, and the comment in the preface that "political whim cannot change the reactions of the blast furnace nor the action of the electric arc," are evidence that the book is written from the engineering, not the Sunday Supplement, point of view, even though aimed for popular consumption.

—H. W. Gillett

Other New Books

Encyclopedia of Substitutes and Synthetics. *Edited by Morris D. Schoengold. Published by Philosophical Library, Inc., New York, 1943. Cloth, 6¼ x 9¼ in., 382 pages. Price $10.00.* As might be expected from the size of this book and the size of the subject, coverage of the field tends to be rather thin and spotty. This is especially noticeable in the metal topics. Many of the substitute steels or alloying elements, such as the NE steels, or the use of boron, are ignored entirely or mentioned vaguely. The book is quite definitely concerned with nonmetals. More careful proofreading might be used to advantage, and at the advertised price one might expect a somewhat better grade of paper to be used. The book does list a large number of industrial chemicals and other products, with substitutes for various uses. It should provide a general guide or suggestion reference in many fields.

Symposium on Powder Metallurgy. *Published by American Society for Testing Materials, Philadelphia, 1943. Paper, 6 x 9 in., 55 pages. Price $1.00.* Seven technical papers with extensive discussions are presented in this pamphlet. Following a paper on the fundamentals necessary to apply powder metallurgy in manufacturing, there is an extensive discussion on the effect of pressure and on the effect of particle size. Alloy powders, metal powder friction materials, hot pressing of metal powders and the influence of homogenization on the physical properties of Cu-Ni powder alloys are included. A number of current problems in this rapidly growing industry are discussed by leading authorities in the field.

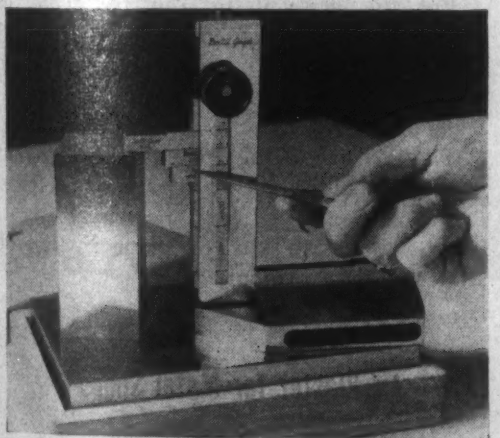
Maintenance Arc Welding. *Published by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio, 1943. Cloth, 5¾ x 8¾ in., 234 pages. Price 50 cents.* This is claimed to be the first volume of its kind on maintenance welding ever to be published. It is the second important book developed from the 1940-1942 Industrial Progress Award Program and comprises 25 of the most significant award papers in the program's maintenance classification. It is suggested that the information contained in this new volume will be found particularly useful in keeping machinery and plants in operation despite critical shortages of materials and equipment. There are 242 illustrations in the 25 chapters.

METALLURGICAL ENGINEERING news

Equipment • Finishes • Materials • Methods • Processes • Products
Alloys • Applications • Designs • People • Plants • Societies

Gage for Ten Micro Inches

A new vernier gage in combination with a set of gage blocks permits measurements as fine as ten-millionths of an in. to conform to this age of finer tolerances. This DoAll vernier gage is made by *Continental Machines, Inc.,* 1301 Washington Ave. South, Minneapolis 4.



The added versatility of this gage and blocks greatly reduces costs of producing special gages where the dimensions must be held to split tenth accuracy.

Gage blocks, with the new vernier gage, can be quickly set up to produce practically all types of snap gages, height gages and depth gages to millionth accuracy at a fraction of the cost of a special gage.

In combination with gage blocks, a precision sine bar can be set to angles with 2 sec. of an arc. Tool makers and inspectors can quickly measure any dimension to within 10 micro inches.

The gage consists of two gage blocks having a precision taper on their mating faces. When the taper faces of two blocks are wrung together with their taper index marks coinciding, the blocks form a gage block whose height is 0.700 in. One block is graduated into ten equal parts between the index graduations.

By sliding this block to the right, the height of the vernier gage is increased ten-millionths for each graduation because of the taper. Sliding the block to the left, the height of the vernier gage is decreased ten-millionths of an in. for each graduation.

In the accompanying photograph is the vernier gage, with precision gage blocks, gage block holder and master flats, in the making up of a height gage. This set-up, from a standard set of 81 gage blocks, will measure heights up to 12 in. in increments of ten micro in.

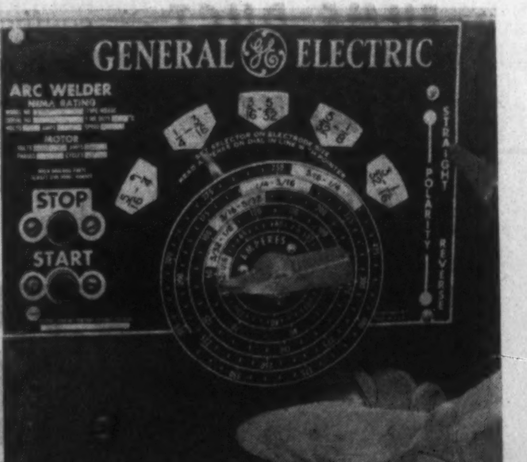
D.C. Welders

Two new control dials and a redesigned driving motor are features of a new d.c. single operator arc welder, Type WD-30 series of *General Electric Co.,* Schenectady. The control dials permit the welding current to be preset without the aid of a volt-ammeter, and the driving motor is designed to give exceptional resistance to the weather, when operated outdoors.

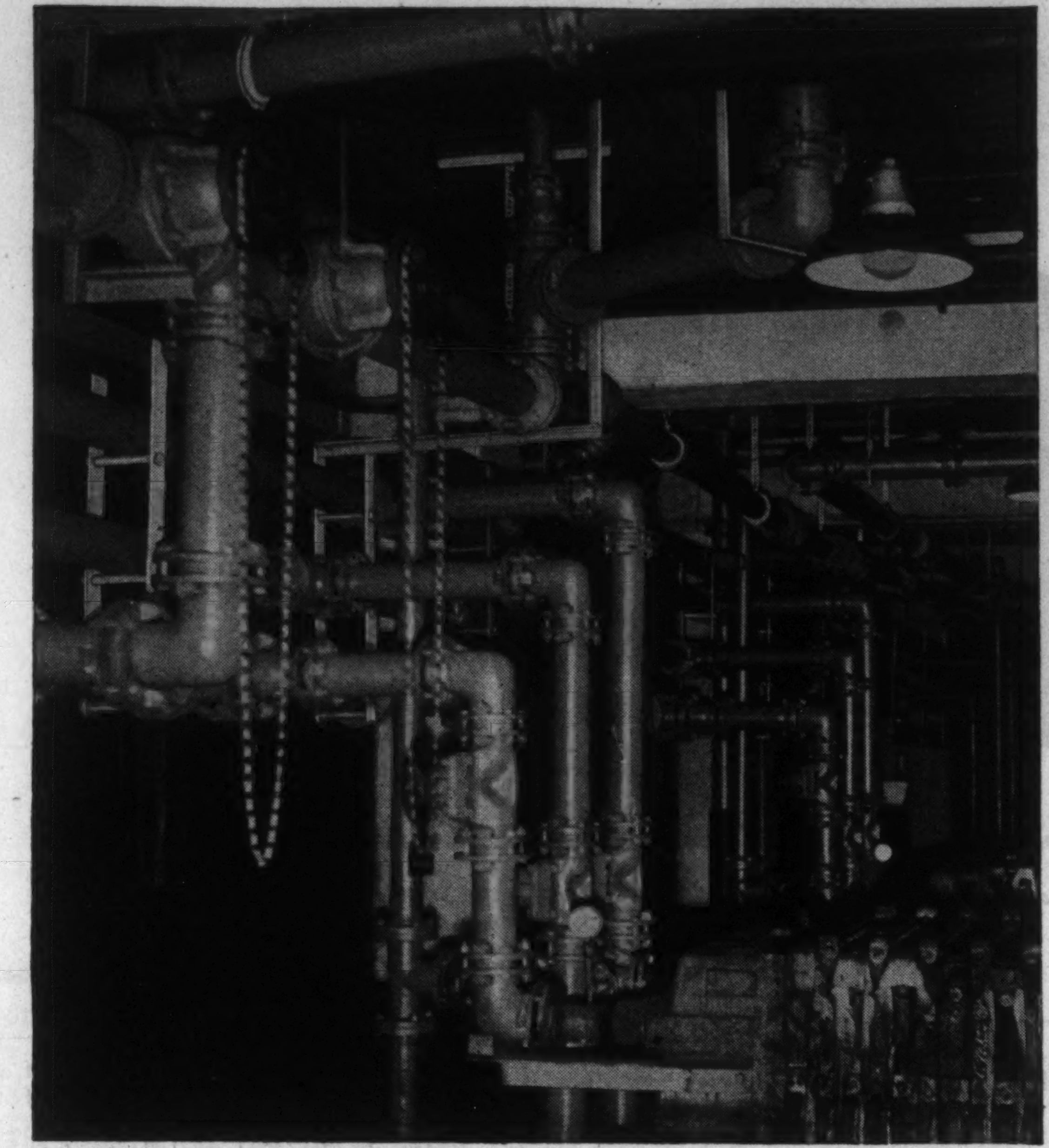
Large and conveniently located, one of the control dials is calibrated in terms of electrode size, the operator setting to correspond to the size of electrode being used. The other dial indicates the range of welding current available for use under these conditions.

The operator presets the welding current merely by rotating a pointer to whatever amperage he wishes. All calibrations are easily read.

The motor has heavier insulation and other protective features. Enlarged intake openings for ventilating air keeps the air velocity low enough to prevent rain or snow from being drawn in, while a large baffle back of the openings prevents water from splashing into the motor.



Tests reveal that the new insulation is far more resistant to deterioration from salt spray than insulation previously furnished.



ACID and ALKALI *have no effect* on HAVEG

- PIPING
- FITTING
- VALVES
- FUME DUCT
- TANKS
- TOWERS

HAVEG is a molded asbestos plastic which is completely chemically resistant throughout its entire mass. All standard sizes of pipe, valves, fittings and fume duct are available. Non-standard sizes, and specially designed equipment are readily and economically molded. Send today for Bulletin F-3 which gives complete design, application and installation data.

***HAVEG-SARAN** Tubing; Pipe & Fittings; and sheets are available from stock. **HAVEG-SARAN** is also described in Bulletin F-3. Send for a copy now.*

HR-43

HAVEG CORPORATION
NEWARK, DELAWARE
FACTORY–MARSHALLTON, DELAWARE

CLEVELAND
550 Leader Building

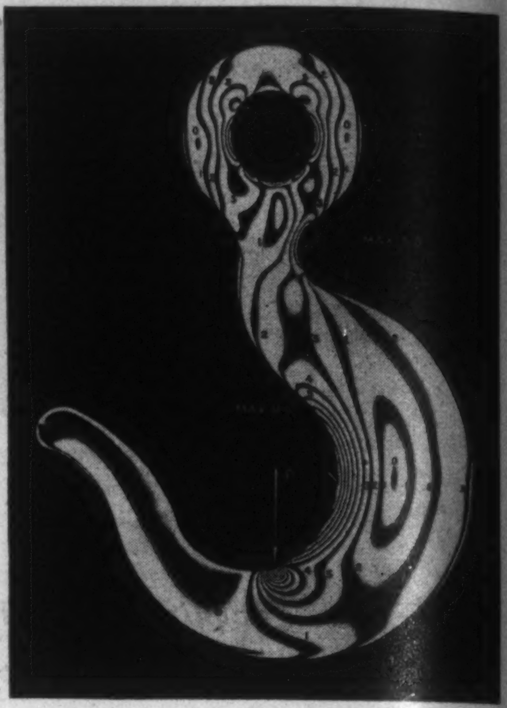
CHICAGO
1201 Palmolive Building

DETROIT
2832 E. Grand Blvd.

LOS ANGELES
601 W. Fifth St.

New Plastic for Stress Studies

In connection with a series of experiments along lines foreign to the discovery finally made, a certain plastic was developed suitable for 3-dimensional models for photo-elastic stress studies. After the transparent material is stressed in a realistic manner by *Westinghouse* engineers, the stress lines show up as different colors when observed under polarized light.



Heretofore, suitable plastics for these models could be obtained only in small pieces — sheets measured less than 100 sq. in. and were only ¾ in. thick. It took up to a year to cure the material satisfactorily.

But the new plastic can be made in sheets, 600 in. square by 3 in. thick, and can be cured in two days. Larger pieces will permit stress analysis of large full-scale models.

The accompanying photograph is that of a transparent plastic model of a crane hook photographed by polarized light, which vibrates in a single plane instead of scattering like ordinary light.

Air Blaster for Metal Shops

For use in steel mills, foundries, forge rooms, etc., the new "air blaster" of the *Chelsea Fan & Blower Co., Inc.,* 1206 Grove St., Irvington, N. J., delivers a large volume of air in a straight line to the spot where it is needed, reaching more effectively into out-of-the-way corners and dead air spaces.

Unlike ordinary fans, the discharge expands only slightly and continues as a high velocity air stream over large distances. The unit consists of a heavy gage welded steel housing, mounted on an adjustable pedestal, which may be tilted 60° up or down. It is driven by a direct-connected, ball bearing motor.

The blade is of heavy steel, die cut, die formed and perfectly balanced. It is made in three sizes.

the BIG 8 are back

These Versatile TOOL STEELS... with original prewar analyses... are again available for your tool and die jobs

For many months, Bethlehem has been unable to supply certain standard brands of tool steel for general distribution. *But this is no longer true of eight very popular grades—eight types that will handle 97 per cent of your jobs requiring tool steel.*

And here's more news: These highly-versatile tool steels are back *on prewar compositions;* they are not substitute analyses. For this reason, they can be relied upon to do the same dependable job that they were doing in thousands of shops before war-time shortages.

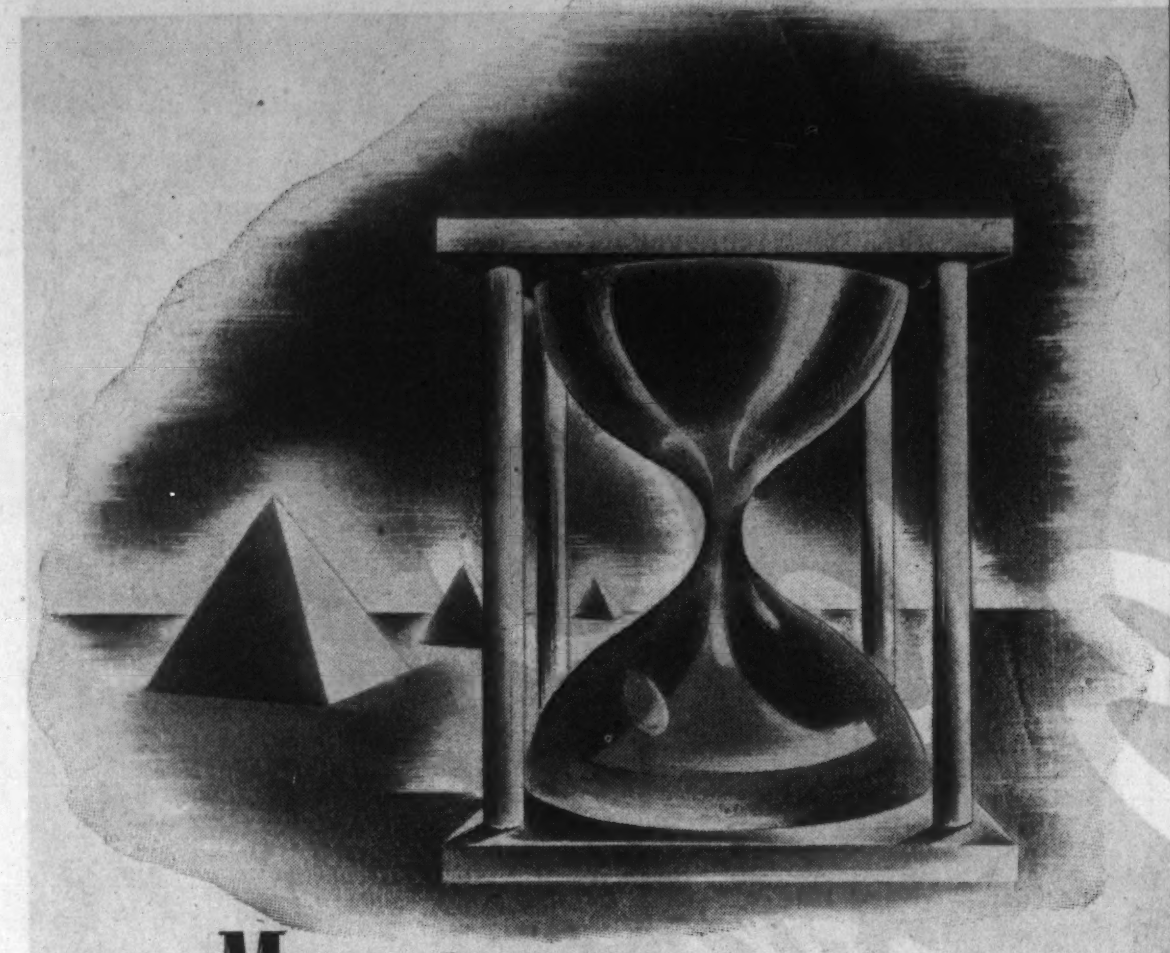
The Big 8 Bethlehem Tool Steels, once more available to shop men generally, are as follows:

- **CARBON TOOL STEEL**
- **TOOL ROOM**
- **OMEGA**
- **NO. 67 CHISEL**
- **AIR-HARDENING**
- **LEHIGH DIE AND TOOL, H TEMPER**
- **NO. 57 HOT WORK**
- **NO. 66 HIGH SPEED**

If these eight steels are old friends of yours, you can now get acquainted with them all over again. If you haven't used them before, why not let us tell you about their applications and advantages?

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.
Bethlehem Steel Export Corporation
New York City

★ BETHLEHEM STEEL ★



Miracles with minutes★

INDUSTRY fights an eternal battle with time. Reduction of costs and increasing production depend upon packing each minute with achievement. In abrasive blast cleaning the nearest thing to miracle working equipment is the Airless Wheelabrator. It slashes hours to minutes!★

The Wheelabrator has met the need for low-cost, speed cleaning of castings, forgings, heat-treated parts, stampings, etc., in several thousand plants. Many of these applications have been designed to meet special cleaning or finishing problems on such products as: airplane engines, shells, bombs, sanitary ware, locomotive flues, and others.

Directional control of the abrasive blast is achieved mechanically by harnessing centrifugal force. Compressed air is thereby eliminated—and with it go excessive horsepower requirements and expensive investments in compressed air equipment.

Perhaps you have some troublesome, time-consuming, costly cleaning operation that needs correcting. If so, tell us about it and we will respond with suggestions, based on wide experience, showing how your situation can be solved at low cost.

★ 3 Days Cut to 3 Hours

Cushman Chuck Co., Hartford, Conn., cleaned the same amount of work with the Airless Wheelabrator in the first three hours of its operation that had previously required three days to handle in their old air blast cabinet.

★ Time Cut One Third

Plainville Castings Co., Westfield, Mass., cleans in 8 hours with the Airless Wheelabrator the same amount of gray iron castings that had previously required 24 hours in their old rolling barrel method.

American
FOUNDRY EQUIPMENT CO.
538 SOUTH BYRKIT STREET • MISHAWAKA, INDIANA

Dual Temperature Test Cabinet

A new dual temperature test cabinet for sub-zero and high temperature testing is introduced by *Revco, Inc.*, Deerfield, Mich. It will reduce the temperature in a 90° F. room from 180° F. to minus 70° F. in 6 hrs. Likewise, the heating cycle from minus 70° to 180° F. can be accomplished in 1 hr.

Any desired temperature will be held automatically by turning the control dial pointer to the proper figure. Temperature control is accurate to ± 1° F.

Solenoid-operated duct doors and positive air circulation make for most efficient and rapid temperature changes when required.

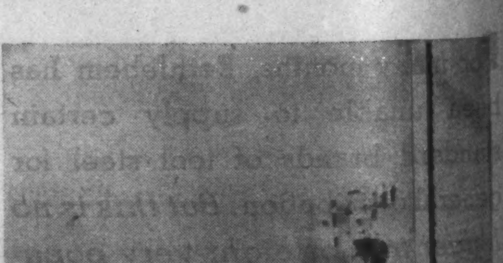
● Previously *E. W. Bliss Co.*, Toledo, Ohio, built top enclosures or domes for presses out of 1/8 in. plate, but finished appearance was not satisfactory and fabricating costs high. Now they use Lindsay structures, completely prefabricated to individual needs and shipped knocked down by *Lindsay and Lindsay*, 222 W. Adams St., Chicago 6. They are designed in two sections so that assembly can be handled from both sides of the high presses. Now appearance is good and cost savings have accrued.

Combustion Tube Laboratory Furnace

A new combustion tube furnace for the laboratory for fast carbon and sulphur determination, as well as gravimetric determination of carbon and all alloy steels, is announced by *Lindberg Engineering Co.*, 2444 W. Hubbard St., Chicago 12.

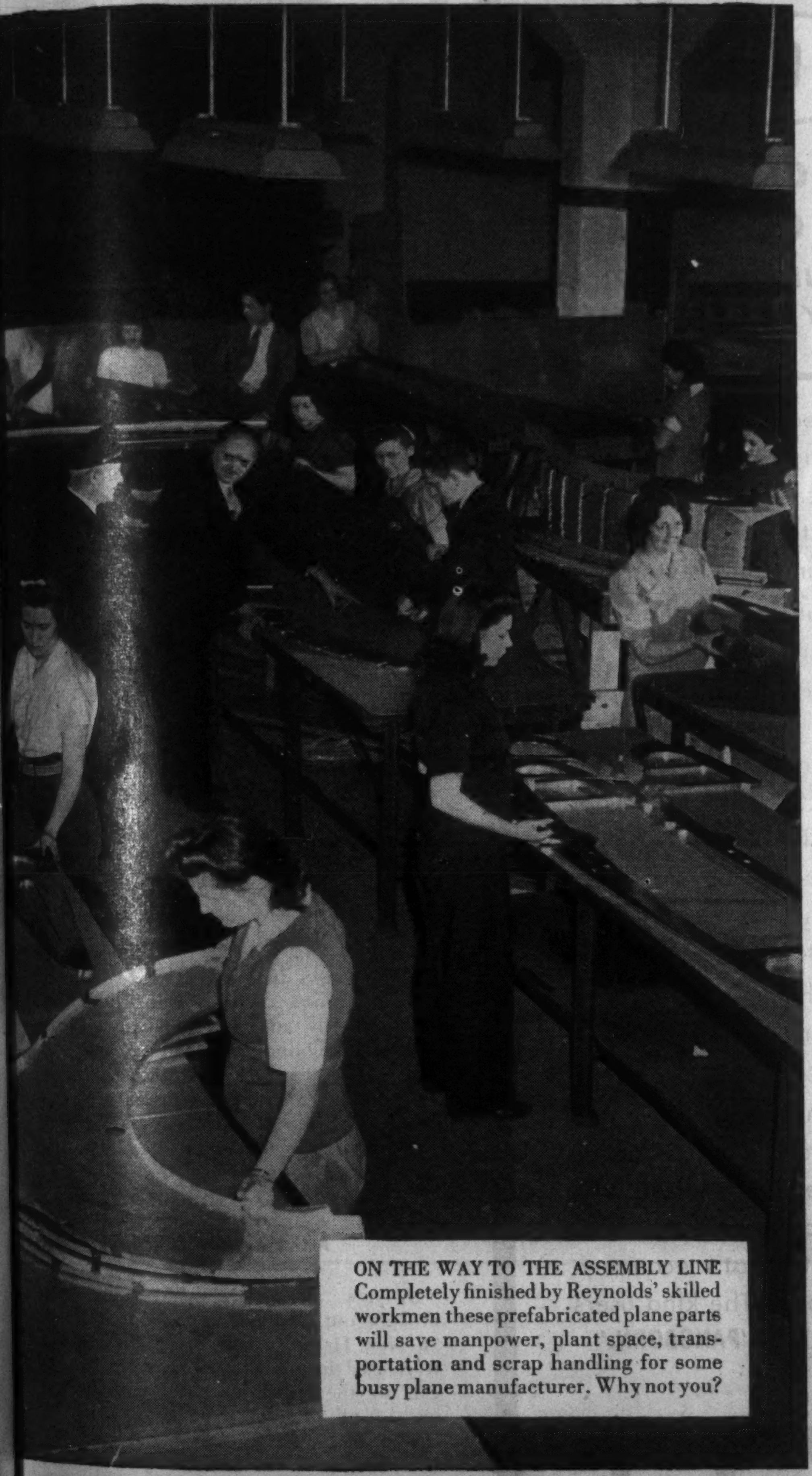
Temperatures obtainable for continuous operation in this CF-1 single tube furnace are up to 2500° F., or even 2650°. High-temperature Globar elements are installed easily or removed without total dismantling and assembling of unit.

Among the necessary controls on the furnace face are temperature regulation, an ammeter, pyrometer, flow of oxygen, line cut-off switch and signal light indicating operation.



These units have 3 adapters for interchangeability of standard combustion tubes, 1 in., 1¼ in. and 1½ in. O.D. A fourth tube, 2 in., can be used without adapter.

Thousands of man-hours SAVED . . .



ON THE WAY TO THE ASSEMBLY LINE
Completely finished by Reynolds' skilled workmen these prefabricated plane parts will save manpower, plant space, transportation and scrap handling for some busy plane manufacturer. Why not you?

by Prefabricated Plane Parts Service . . . Pioneered by REYNOLDS

Here's one answer to your manpower shortage. An answer that's already saving thousands of precious man-hours of airplane labor for every leading manufacturer of combat planes.

Under this plan, pioneered by Reynolds only 3 years ago, completely finished parts come to your production lines ready for immediate assembly. No longer is it necessary to tie up valuable plant space with large stocks of aluminum sheet or die-cutting and forming machines.

Big savings in scrap handling realized

The Reynolds prefabricated plane parts service also does away with scrap handling. Aluminum scrap, which averages 30% of every sheet, is immediately re-rolled into prime sheet, then prefabricated into more new parts, practically overnight.

It is this kind of progressive thinking and co-operative planning that has resulted in an organization which now operates 40 plants in 14 states, and continues to grow by leaps and bounds. For Reynolds men are not satisfied to have been the first to supply finished plane parts from aluminum sheet. They have given themselves the continuous job of finding new ways to make aluminum better . . . easier and cheaper to use.

That's why you'll find Reynolds' resources, equipment and engineering skill can be of assistance in helping you with your aluminum problems, *no matter what they may be.* Reynolds Metals Company, Aluminum and Parts Divisions, Louisville, Ky.

REYNOLDS *The Great New Source of* **ALUMINUM**

INGOT · SHEET · EXTRUSIONS · WIRE · ROD · BAR · FORGINGS · TUBING · FOIL · POWDER

FLASH! 700

BLAST CLEANING MACHINES JUST ORDERED BY ONE CUSTOMER!

PANGBORN GETS LARGEST SINGLE CONTRACT EVER PLACED FOR THIS TYPE EQUIPMENT

ROTOBLAST* means faster cleaning of castings, forgings, stampings, heat-treated parts, etc.—with the cleaned surfaces in perfect condition for faster machining, grinding and metallizing.

ROTOBLAST means substantial blast equipment expertly designed for faster production of all sizes and shapes of work. BARRELS hold all miscellaneous foundry work of average type. TABLES—both single and multi-spindle, for flat or fragile pieces. SPECIAL MACHINES for automatic cleaning of continuous work such as cylinder blocks, etc.

ROTOBLAST machines are sturdy—built for long hours of production.

"ROTOBLASTING" is economical. When one man finishes in half a shift what five men formerly did in their full time—when power and labor and wear are all reduced to a fraction of their previous cost—that's economy.

ROTOBLAST economy. The kind users get when they **COME TO 'PANGBORN.'**

ARMY E NAVY

*Trade mark of Pangborn Corporation for airless blast cleaning.

PANGBORN

WORLD'S LARGEST MANUFACTURER OF DUST COLLECTING AND BLAST CLEANING EQUIPMENT

PANGBORN CORPORATION · HAGERSTOWN, MD.

Files of Cemented Carbide

A new and revolutionary type of file made of high strength cemented carbide is announced by *Kennametal, Inc.*, 158 Lloyd Ave., Latrobe, Pa. Ordinary steel files to remove burrs tend to break down at modern high cutting speeds. But the new Kennametal files will permit speeds 3 to 10 times that possible with steel files, and outlast them 50 to 200 times.

Inset shows portion of filing surface actual size, unretouched.

They will cut steels up to 62 Rockwell C hardness and do a noteworthy job on cast iron and brass at surface speeds of 900 ft. per min. High carbon, high chromium steels have been filed at 800 s.f.m., with files in good condition after 3 weeks, as against only one day of work with steel files.

The file is 11 in. long, ¾ in. wide and ⅜ in. thick, having a substantial filing surface 4 in. long, made of grade K4H Kennametal (80.6 Rockwell C), single cut with teeth at 30° shear angle, 40 per in.

● In a new diamond bonded wheel the bonding process sets each individual diamond solidly and uniformly in a special metal, promoting fast cutting and long life. It is made by *Industrial Abrasives, Inc.*, 3724 W. 38th St., Chicago 32.

Alkali Steel Cleaner

A new alkali steel cleaner has been brought out by the *Enthone Co.*, 442 Elm St, New Haven, Conn., called Cleaner 100. It is used in a concentration from 4-8 oz.-gal. in the temperature range from 180 to 212° F.

The maker claims very high detergency. It is best used anodically, but is an effective immersion cleaner.

Cleaner 100 contains no soap such as rosin soap, but rather complex phosphates to solubilize any fatty acid soap that may form from greases and oils being cleaned. It is effective in soft and very hard water, and does not form insoluble residues due to reaction with acids.

NEW STEEL
developed by Timken

HURTLES JET PROPULSION PLANES
THROUGH SUB-STRATOSPHERE

BURSTING upon a gaping world Jet Propulsion Planes flying at breath-taking heights, are hurtling through the air at furious speeds.

The success of these planes, which give ultimate promise that distances formerly hours long, will be radically reduced, is a salute to American and British Engineering ingenuity.

Many problems had to be overcome in perfecting these super planes, that are being readied to strike devastating blows against our enemies.

One, was to find a steel for the turbine wheel that could withstand heat so great that it reduced ordinary alloy steels to a plastic state. The steel required had to possess herculean strength, to stand up under the tremendous centrifugal force developed by the turbine wheel spinning thousands of revolutions per minute.

Timken's metallurgists, long experienced in developing special alloy steels for specific applications, provided the solution to this knotty problem. The steel they developed for use in the Turbosupercharger was able to meet the gruelling requirements of the turbine wheel. Steel, that made Jet Propulsion Planes a practical reality today, instead of a vague promise for tomorrow.

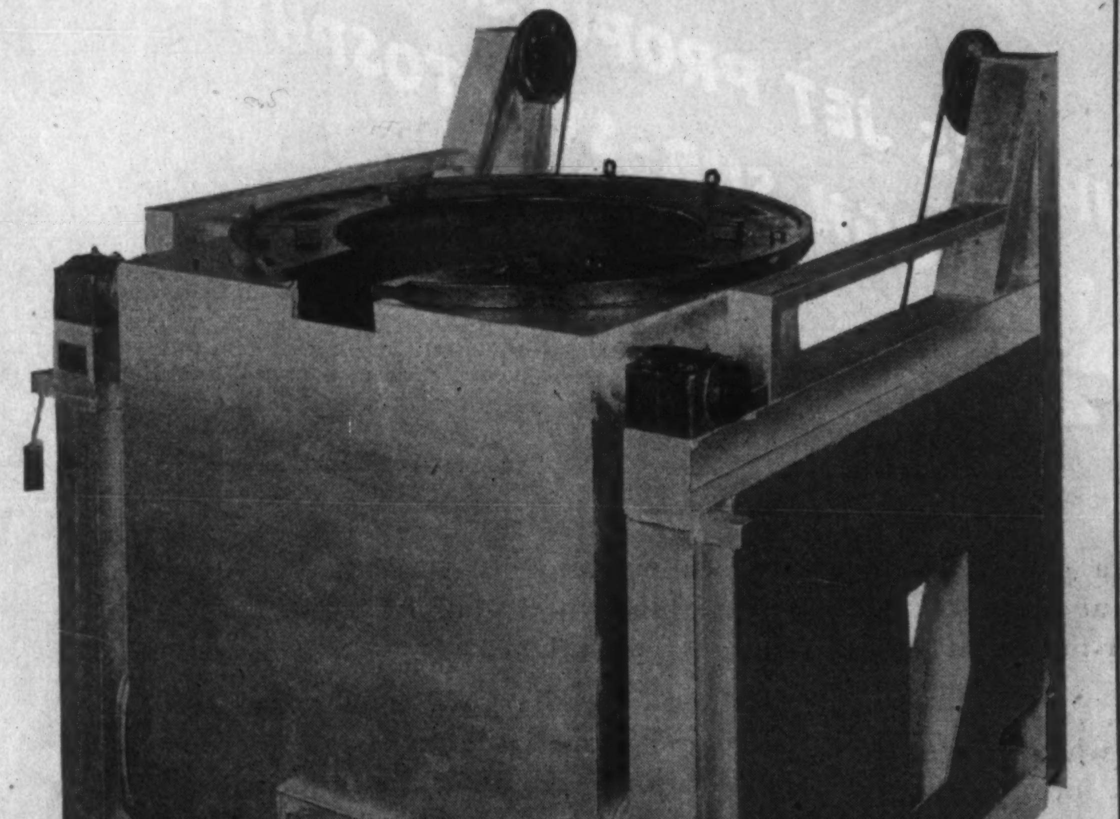
If you have a problem that calls for steel of special qualities consult one of Timken's Engineers. They will be glad to help you select a steel that will meet your requirements. Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE MARK REG. U. S. PAT. OFF.
ALLOY STEELS

MONARCH FURNACES

for Magnesium *and* Aluminum

● *MOTORIZED NOSE POUR*
● *HAND TILTING*
● *STATIONARY*



THE MONARCH ENGINEERING AND MANUFACTURING CO.

Curtis Bay Baltimore, Md.

Semi-Photographic Process Printer

A new printer, the 55C continuous photographic, provides clear and faithful duplicates of anything typed, printed, photographed or drawn. Made by the *Charles Bruning Co., Inc.,* 4700 Montrose Ave., Chicago, it may be used either inside or outside of the dark room, and operates with roll stock or cut sheets.

With a speed up to 18 ft. per minute, it embodies improvements in light source and control, which assure maximum line capacity and clear, contrasting prints. Either a white or amber lamp may be used in making exposures, depending on the nature of the original. A shutter varies the exposure space from 0 to 14 in.

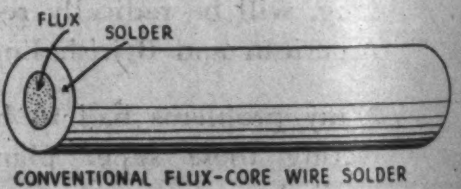
A feature is the exceptionally large print return tray that occupies the entire top of the machine, making for easier handling. Pencil tracings are quickly intensified in the reproduction, saving drafting time. Blue prints, layouts, maps and engineering data are easily reproduced.

● A new grinder shield that provides properly directed light and protection for the face and eyes from flying particles is announced by *Boyer-Campbell Co.,* 6540 Antoine St., Detroit. The window is of non-shatterable glass and the lamps, bayonet-type and vibration resisting, are set in flush with the frame. The frame is of plastics.

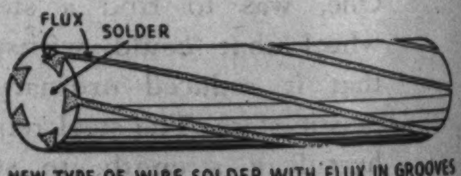
Fluxed Wire Solder

A new fluxed wire solder contains flux in longitudinal grooves on the surface rather than in the conventional core. The maker, *National Lead Co.,* 111 Broadway, N. Y., calls this material "Fluxrite," the first basic improvement in fluxed wire solder design in several years.

Being on the outside, it liquefies and flows into the work before the solder melts, thus insuring thorough and complete fluxing, and making stronger and better solder joints. There is a continuous flow of flux at all times.



CONVENTIONAL FLUX-CORE WIRE SOLDER



NEW TYPE OF WIRE SOLDER WITH FLUX IN GROOVES

Again, being visible to the user, it can be checked quickly and easily. It is available in two compositions, Red stripe and Green stripe.

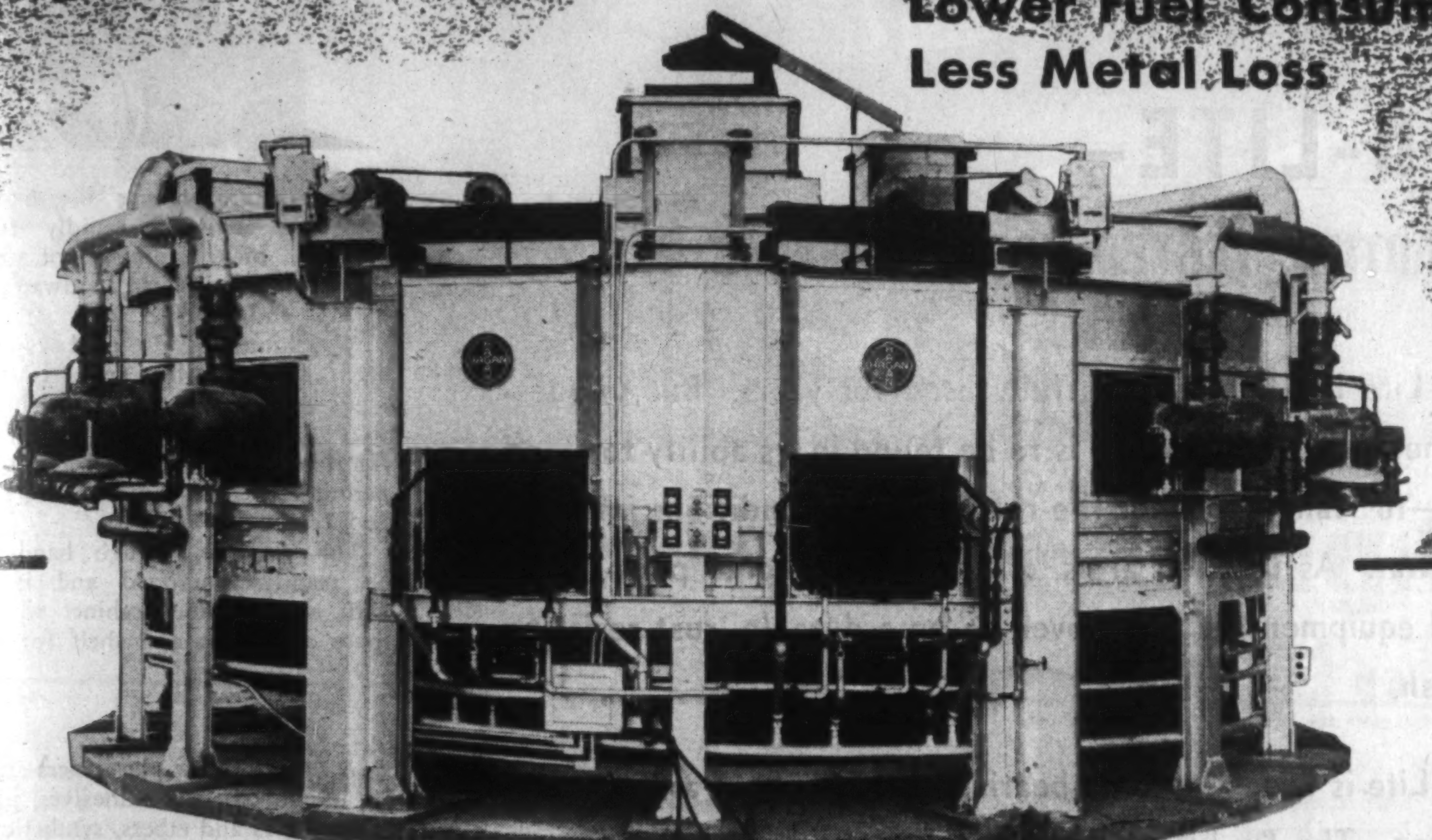
HAGAN

ROTARY HEARTH FORGING

FURNACES

DELIVER **UNIFORMLY HEATED BILLETS**

with Shorter Heating Time
Lower Fuel Consumption
Less Metal Loss



LESS HEATING TIME

Heating time is directly proportional to area exposed where billet size and temperature are fixed. In the Hagan Rotary Hearth Forging Furnace the billets are spaced from each other in either a horizontal or vertical position. This exposes from 80% to 90% of the billet surface area as compared to 40% in the pusher type billet heating furnace where heat is generally applied to the top and end areas only.

LESS FUEL CONSUMPTION

Under actual operating conditions one user of Hagan Rotary Hearth Forging Furnaces reports after several months operations that fuel consumption has been decreased 58% as compared to the open slot type furnaces used previously. Lower furnace temperatures are employed, metal losses are lower, and furnace maintenance costs have been materially reduced.

Over 170 Hagan Rotaries are now successfully heating carbon, alloy and stainless steel billets for forging or upsetting into Crankcases, Propellers, Hub Spiders, Landing Gear Parts, Cylinders, Propeller Shafts, Diesel Engine Parts, Gun Carriage Parts. *Write for our descriptive bulletin.*

GEORGE J. HAGAN COMPANY
PITTSBURGH, PA.
DETROIT CHICAGO LOS ANGELES SAN FRANCISCO

OFFICIAL U. S. NAVY PHOTOGRAPH

DU-LITE—

WARTIME TESTED FOR PEACETIME USE

Du-Lite has been successfully used for years. But unquestioned proof of its worth is to be found in its ability to stand up—to "take it" under the rough, tough conditions imposed by war. As used on arms, airplane and engine parts, tools and equipment, it has proven to be a durable, rust-resisting finish.

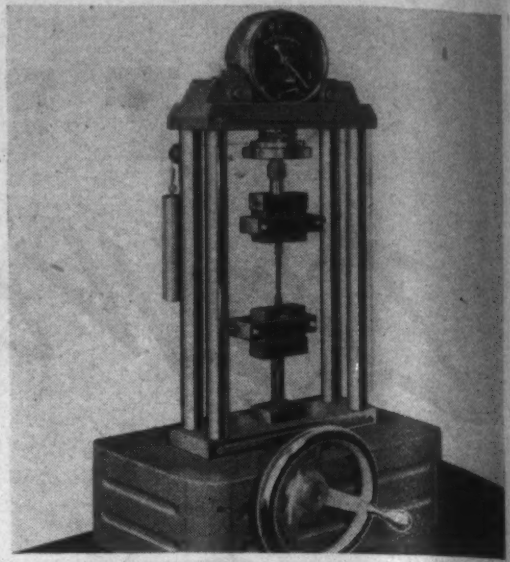
Du-Lite is widely used on bearing surfaces as an aid to lubrication. The Du-Lite processing smooths down microscopic roughness and produces an oxide film that holds oil. Extremely close tolerances can be maintained. Leading airplane and automotive engine manufacturers have found Du-Lite practical and efficient for this purpose.

Du-Lite will find many uses, both as an aid to lubrication and for protection, on many products after the war. If you are looking for help on black oxide finishing, call in the Du-Lite Engineer. His recommendations will not obligate you in any way, and may save you time, money and materials.

DU-LITE CHEMICAL CORP.
MIDDLETOWN, CONNECTICUT

Portable Tensile Tester

A new portable tester for tensile, compression, transverse or shearing tests, is announced by *W. C. Dillon & Co., Inc.*, 5410 W. Harrison St., Chicago 44. The following are among the materials that may be analyzed rapidly for relative strength: brazed joints, spot welds, standard rounds or flats, hardware, porcelain, springs and bakelite.



Weighing 132 lb. and 25 in. tall, it starts at 0-250 lb., and has seven intermediate and interchangeable indicators up to 0-10,000 lb. It has a new holder design for standard V wedge serrated grips, which permit especially rapid specimen insertions and removal.

The machine, though hand-driven, can be readily motorized and is obtainable with a metal floor cabinet with specimen space and room and shelf for motorizing.

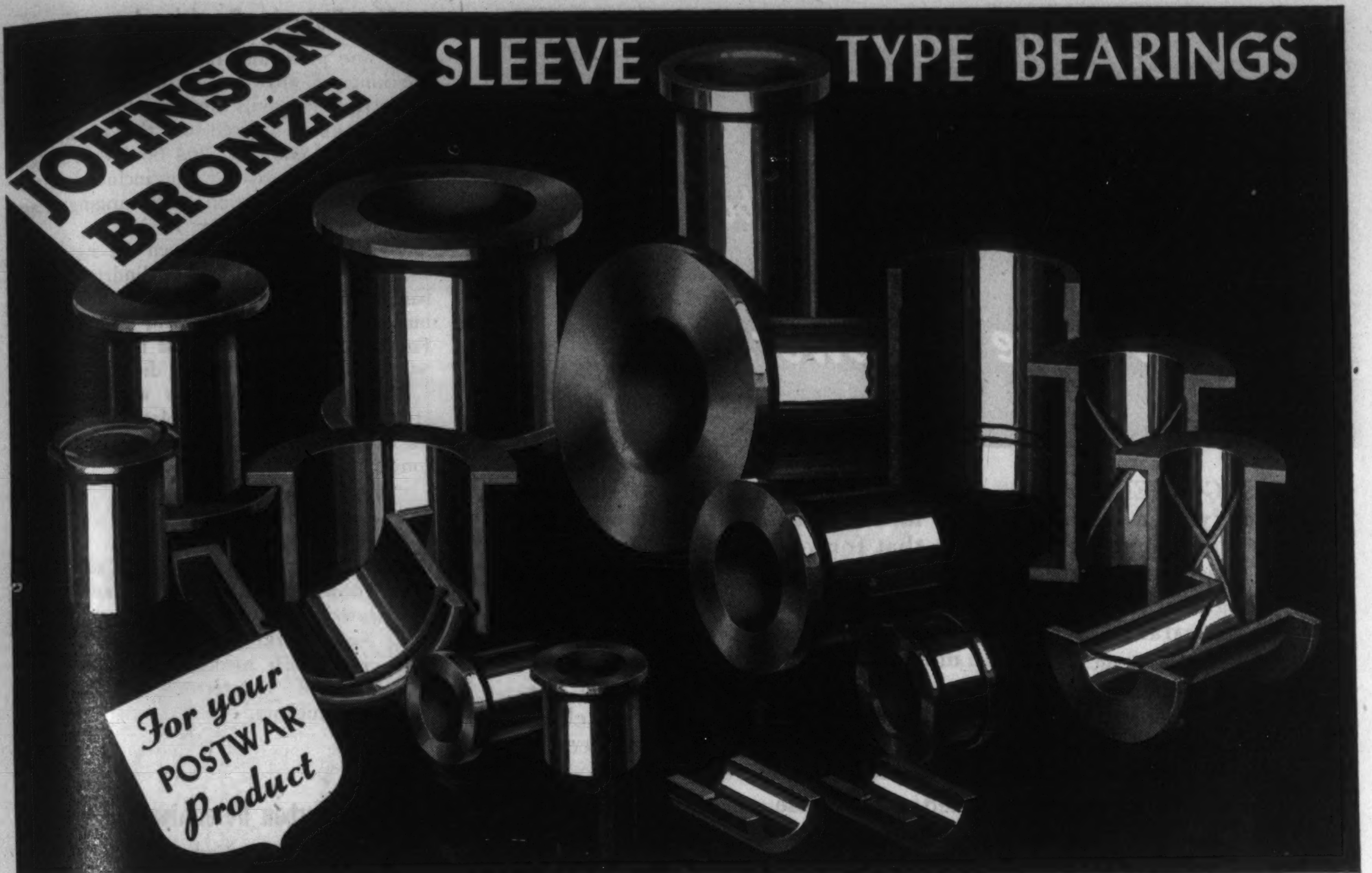
● A series of new plasticizers and softeners for use in coatings, adhesives, plastics, cellulose esters and ethers, synthetic resins and synthetic rubbers is now being produced commercially, states *Glyco Products Co., Inc.*, 26 Court St., Brooklyn. They consist of alkyl and alkyl ether esters of higher fatty acids and dicarboxyllic acids, and have low freezing points and very mild odors.

Thermocouple for Cyanide Carburizing

A new type thermocouple, the "Carbucouple," for cyanide carburizing in the heat treating and allied industries, has been brought out by the *Brown Instrument Co.*, Philadelphia. It features a uniquely designed "hot" leg, consisting of an outer tube that has been heat-treated and surface conditioned by a special process, and an inner ceramic tube to protect thermocouple accuracy.

The maker claims a lower base cost, greater durability and sensitivity and assured accuracy. It is built of non-critical materials. It is said to have twice the life of thermocouples made with nickel tubes, and is more responsive.

The special inner tube protects the thermocouple element throughout the life of the tubes.



Cast Bronze Bearings *for* Long Life

SLEEVE TYPE BEARINGS

- Cast Bronze Bearings
- Cast Bronze Graphited
- Sheet Bronze Bearings
- Sheet Bronze Graphited
- Bronze and Babbitt Bearings
- Steel and Babbitt Bearings
- Steel and Bronze Bearings
- Ledaloyl
- Self-Lubricating Bearings
- Electric Motor Bearings
- Automotive Bearings
- Bronze Bars
- Bronze Castings

Any Type
Any Size
Any Quantity

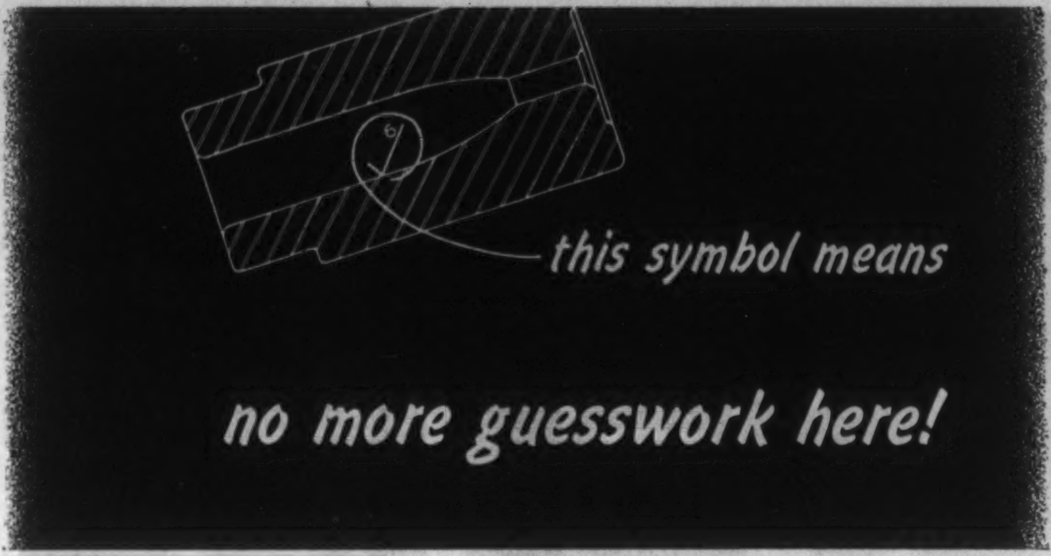
● When you design your new product for tomorrow's market it will pay you to investigate the advisability of using CAST BRONZE bearings.

You gain several distinct advantages in cast bronze. In the first place few bearings deliver the smooth, quiet, efficient performance for so long a time as cast bronze. Properly designed and installed, they will usually outlast the motive unit in which they are used. The initial cost is comparatively low, they are easy to get and easy to replace.

It is not a difficult matter to build this kind of service into your product. Simply call in a Johnson Sales Engineer. Permit him to review your applications, to make recommendations based on facts, free from prejudice. Our more than thirty-five years of exclusive bearing experience plus the fact that we produce ALL types of sleeve bearings enables us to give you the correct answers to your bearing problems. There is a Johnson Sales Engineer as near as your telephone . . . ready and willing to serve you.

DISTRICT SALES OFFICES: Atlanta · Boston · Buffalo · Chicago · Cincinnati · Cleveland · Dallas
Detroit · Kansas City · Los Angeles · Minneapolis · New York · Newark · Philadelphia · Pittsburgh
St. Louis · San Francisco · Seattle

JOHNSON BRONZE
SLEEVE BEARING HEADQUARTERS
The MOST COMPLETE SLEEVE BEARING SERVICE *in the* WORLD
769 S. MILL STREET NEW CASTLE, PA.



THE ENGINEER, by using this symbol (or one of its variations), is specifying a definite surface finish measured in microinches. He has eliminated the guesswork that for years went into production of satisfactory surface finishes.

The engineer need no longer rely on the designation "*f* = smooth machined surface . . . " which he knows may produce as many different surfaces as there are men in charge of making the part.

And in preparing his specifications, the engineer can call for the surface most suitable for the work the part has to do. Very close tolerances can be set for the production of very smooth surfaces—or of rough surfaces where a pre-defined roughness is wanted.

The Profilometer* has enabled the simple, accurate measurement of surface roughness—making possible the fullest use of the roughness symbol shown. With the Profilometer, each part may be accurately checked on a production basis to make sure it meets blueprint specifications for surface roughness.

Roughness control by means of Profilometer readings has facilitated finishing to dimensions, prevented waste of materials and time, and enabled production of better surfaces on millions of machined parts going into war machines. Wartime experience in this regard indicates extensive application of surface-roughness control in peacetime manufacture. Inquiries are invited from manufacturers looking ahead to peacetime production.

The Profilometer . . .

The basic Profilometer unit is a complete shop instrument for measuring average surface roughness. Nearly all surfaces can be measured with this unit. This unit is supplemented by standard accessories available in the form of extra Tracers, piloting fixtures, and other devices to facilitate production measuring on very smooth surfaces, odd-shaped surfaces, and in slots, grooves, small holes and on tapers.

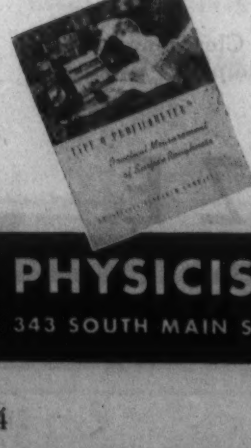
Our Application Engineering Department is fully equipped for the design and manufacture of special jigs and fixtures where standard equipment is not adaptable.

To help you with your surface-roughness problems, we would be glad to demonstrate the Profilometer equipment in your plant and on your parts, at your convenience and at no obligation to you.

May we send you a copy of our booklet *Practical Measurement of Surface Roughness*? In it is described the technic of surface-roughness measurement and the complete Profilometer equipment.

***Profilometer is a registered trademark indicating Physicists Research Company's brand of surface-roughness gaging equipment**

PHYSICISTS RESEARCH COMPANY
343 SOUTH MAIN STREET · ANN ARBOR, MICHIGAN



Sine Plate for Precision Inspection

A sine plate that facilitates the accurate checking of angular measurements in the inspection of tools and production parts has just been placed on the market by the *Carruth Sales Co.,* 704 Boulevard Bldg., Detroit. It measures the included angle on tools or production parts ranging from extremely small to 6 x 10 in.

The desired angle between the stationary locating plate and the cylindrical gage bar on the movable block is obtained by building up the angle with gage blocks. For clamping the work, the block contains 54 tapped holes, 3/8 in. in diam.

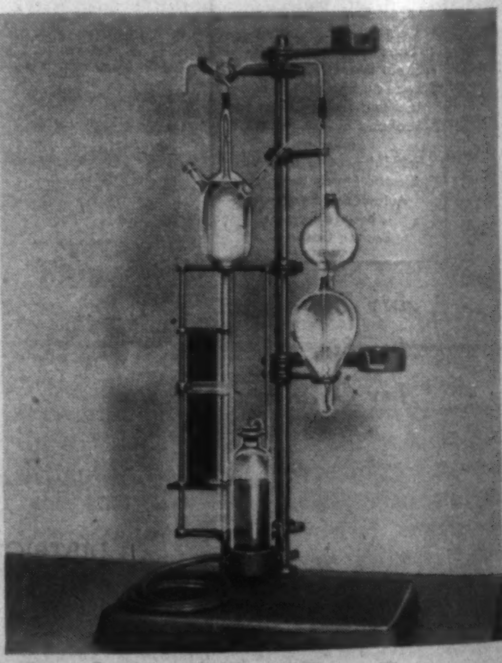
The movable block has a guide plate at one end and a guide plate that can be used on either side, whichever is more convenient.

● A new line of metal-working soft hammers, known as "Metocraft," is announced by *Industrial Products Suppliers,* 2 Broadway, New York. They are available in three grades: soft, medium and hard. Heads are made of non-ferrous metals, with handles of hickory.

Carbon Determinator

A "Two Minute Carbon Determinator" for rapid and accurate total carbon determinations of all metals is announced by *Harry W. Dietert Co.,* 9330 Roselawn Ave., Detroit 4. New features that eliminate much of the human equation are incorporated.

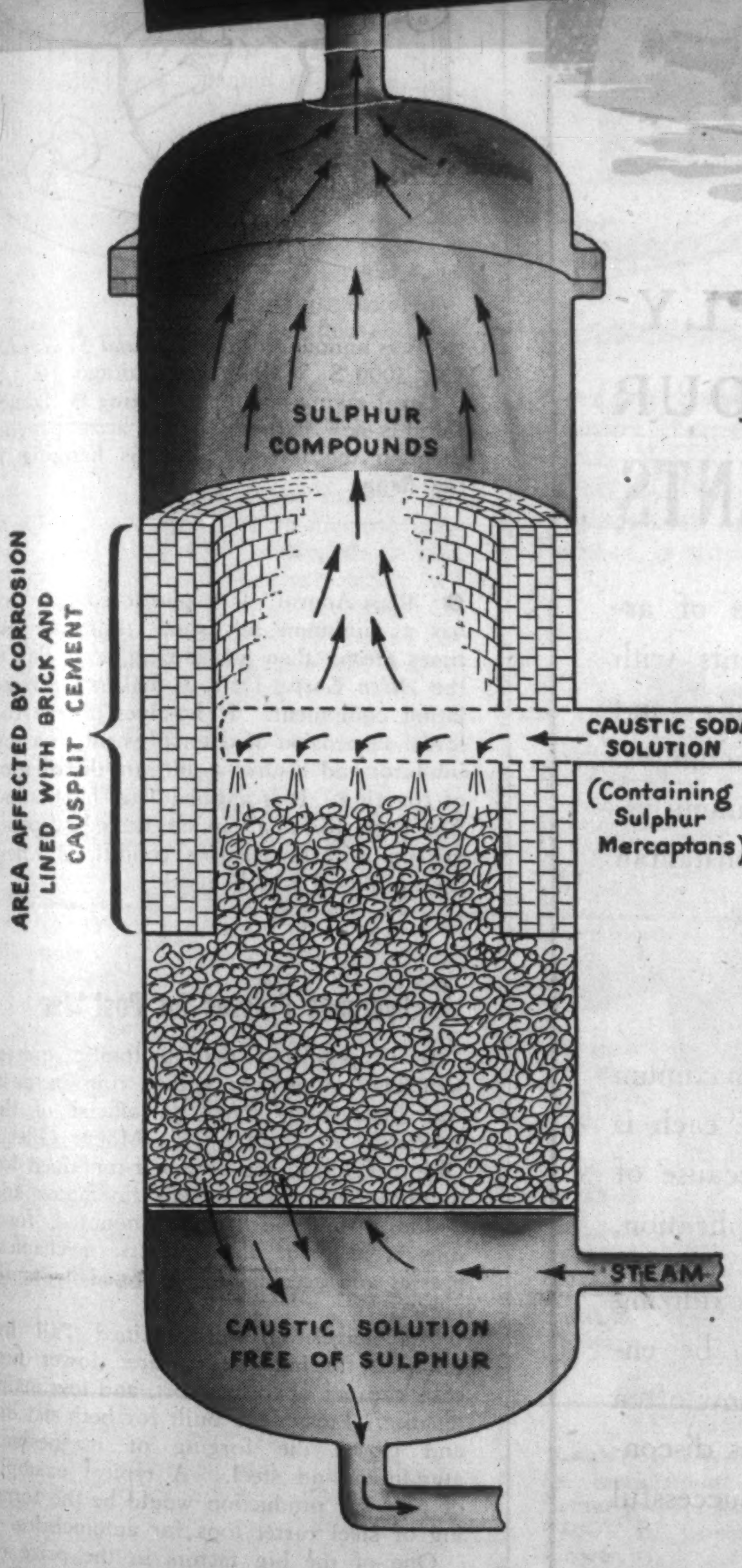
The gas pressure in both the measuring burette and carbon dioxide absorption vessel is automatically brought to the same atmospheric pressure, thus eliminating the possibility of inaccurate reading due to the difference in gas pressure at the start and end of test. The gas pressure in the measuring burette is precisely brought to atmospheric pressure at the time the reading is taken.

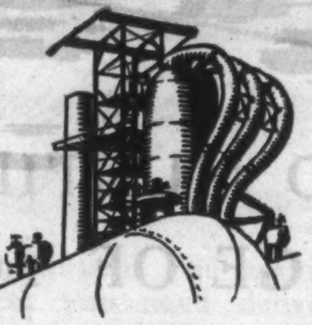


The sample is burned in the combustion tube in a partial vacuum that aids in the complete combustion of the sample.

When repairs call for ACTION -- depend on PENNSALT CAUSPLIT CEMENT

REG. U. S. PAT. OFF.


SULPHUR COMPOUNDS
AREA AFFECTED BY CORROSION LINED WITH BRICK AND CAUSPLIT CEMENT
CAUSTIC SODA SOLUTION
(Containing Sulphur Mercaptans)
STEAM
CAUSTIC SOLUTION FREE OF SULPHUR



At a leading oil refinery emergency repairs were required on the lining of a Mercaptan Tower . . . because of sulphur erosion at the intake area.

The engineers in charge thought they were faced with a three-day shut-down for repairs, with the resultant loss of production.

A Penn Salt technician was called in and after going over the situation he recommended Causplit Cement in conjunction with corrosion-resistant brick. He gave installation instructions and four courses of the brick were used with Causplit Cement as the bonding material throughout. Drying was speeded by heating the tower to 100 degrees F. *and the equipment was back in service the next day!*

Pennsalt Causplit* and Asplit* are resin cements—exceptionally strong, abrasion-resistant and easy to handle. Causplit is used where conditions are alternately acid and alkali . . . Asplit where conditions are always acid.

Pennsalt Penchlor* Acid-proof Cement is a quick-setting, self-hardening sodium silicate cement that will save time in construction and stand up well under severe acid conditions.

Consult Penn Salt technicians about *your* acid or alkali handling problems. Their wide experience is available without obligation. Write fully or return the coupon.

Causplit and Asplit can be supplied only for essential service . . . Penchlor Acid-proof Cement is available without restriction.

PENNSYLVANIA SALT MANUFACTURING COMPANY
Chemicals
1000 WIDENER BUILDING, PHILADELPHIA 7, PA.
New York • Chicago • St. Louis • Pittsburgh • Minneapolis • Wyandotte • Tacoma

PENNSYLVANIA SALT MANUFACTURING COMPANY
Dept. MA, 1000 Widener Bldg., Philadelphia 7, Pa.
I would like to have a free copy of your new booklet No. 6 on Penchlor Acid-proof Cement.
NAME____________________
TITLE____________________
COMPANY____________________
ADDRESS____________________

*Trade-marks Reg. U. S. Pat. Off.

Engelhard Thermocouples

TO MULTIPLY
THE RANGE OF YOUR
PYROMETER INSTRUMENTS

ENGELHARD manufactures a complete range of assembled thermocouples consisting of thermo-elements with insulators, protection tubes, terminal heads, couplings and various accessories. Thermo-elements may be platinum vs. 90% platinum 10% Rhodium, Reclaiming Platinum vs. Platinum Rhodium, Chromel vs. Alumel, Iron vs. Constantan and Copper vs. Constantan.

Selection Is Important

ENGELHARD assembled Thermocouples insure maximum efficiency from their pyrometer instruments because each is made up from selected individual parts, chosen because of their ability to meet the requirements of a specific application.

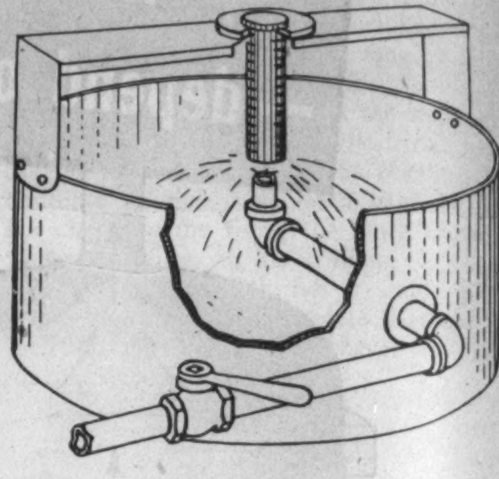
Whether the atmosphere encountered is reducing, oxidizing or corrosive—the maximum temperatures likely to be encountered, probable quick changes in temperatures, how often the thermocouple will be removed or the lead wires disconnected—these are only a few of the main points in successful thermocouple selection.

Take your Thermocouple problems to Engelhard!

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST., NEWARK, NEW JERSEY

Fixture for Jominy Test

A new fixture, with accessory tongs, for making easy the Jominy end quench hardenability test for treatment of N.E.



steels is announced by the *Claud S. Gordon Co.*, 3000 S. Wallace St., Chicago 16.

Great saving of time of testing is claimed for this new fixture. In the accompanying diagram the test specimen is hanging in the flange.

● "Plast-Anneal" is a plastic coating that has a minimum salt spray resistance five times greater than galvanizing, according to the *Allen Corp.*, Detroit, makers of ventilating equipment. It involves a true colloidal suspension of color pigment, is a rust inhibitor and insures a uniform distribution of covering. It is applied after fabrication. The basic formula can be altered, depending on acid or alkaline conditions where the equipment is to be used.

Hydraulic Presses for Post-War

It is predicted that hydraulic presses will play a very important role in postwar production, states an official of the *Hydraulic Press Mfg. Co.*, Mount Gilead, Ohio. Prior to the new self-contained hydraulic press with its electric motor and hydraulic pump integrally mounted, forgings were made in hammers, mechanical presses and accumulator operated hydraulic presses.

Advantages of self-contained "all hydraulic" forging presses are: lower first cost, cheaper operating cost, and less maintenance. Presses are built for both flat die and closed die forging of magnesium, aluminum and steel. A typical example of post-war production would be the forming of steel turret tops for automobiles.

One of the big factors in the price of pre-war articles was the high cost of dies. This has been eliminated by the hydraulic rubber pad forming press. The new hydraulic stretching machine will be used in peacetime for making parts for aircraft, buses, funeral cars, automobiles, etc. Though the hydraulic stretching press requires more stock per formed part, the savings in die costs and large press equipment minimizes this.

(Continued on page 739)

Carbon for Aluminum-Making Electrodes

Seeking a new source of carbon suitable for making the electrodes required in the production of aluminum, *Bureau of Mines* chemists have found that mineral impurities in three low-ash domestic coals may be reduced sufficiently by float-and-sink and acid-leaching processes to yield a coke of the desired quality, Dr. R. R. Sayers, Director of the Bureau of Mines, announces.

Calcined petroleum coke now is the standard material for making electrodes for the aluminum industry. Since about three-quarters of a pound of carbon electrode is consumed for each pound of aluminum produced, a substitute material may become necessary in view of the immensely expanded aluminum production.

Considering coke from coal a possible answer, the Bureau chemists examined seven low-ash coals from eastern Kentucky and Alabama. Ash-forming mineral impurities were removed by a float-and-sink method, by acid treatment, and by a process for cleaning coal with oil and water.

Five of the seven coals tested by the float-and-sink method yielded products with appreciably less than 1.0% ash, but even these contained more mineral impurities than is desirable in electrode carbon. By treating float coals with an acid solution containing 10% hydrochloric and 5% hydrofluoric acid, however, they obtained products with an ash content as low as 0.31%. Acid leaching would be expensive, they acknowledged.

- "Iridite" is a coating for metal plated with zinc or cadmium, which becomes an integral part of the metal. Produced by *Rheem Mfg. Co.*, 30 Rockefeller Plaza, New York, it fulfills the Army Air Corps test of preventing corrosion as demonstrated by the salt spray test (20 per cent salt at 95 deg. F.) for 100 hrs. This does away with the 5 per cent chromic acid dip, thus saving critical metals.

General Purpose A.c-D.c Electrode

A new general-purpose arc welding electrode, "Fleetweld 37," for welding mild steel in all positions, with either alternating or direct current, is announced by the *Lincoln Electric Co.*, Cleveland. It was originally designed as an easy striking, unusually smooth operating electrode primarily for light gage material.

There is no slag interference when welding vertically down. It produces higher welding speeds than normal, and is ideal for general purpose work. It will neither stick to the work nor burn through.

Physical properties of weld metal are: Tensile strength, 70,000 to 80,000 p.s.i.; yield strength, 60,000 to 68,000 p.s.i.; ductility (elongation in 2 in.) 18 to 25%. It conforms to A.W.S. classifications for arc welding electrodes E-6012, E-6013, E-7011 and E-7012.

It is available in the 1/8, 5/32 and 3/16 in. sizes in 14-in. lengths, and is packed in 50-lb. standard containers.

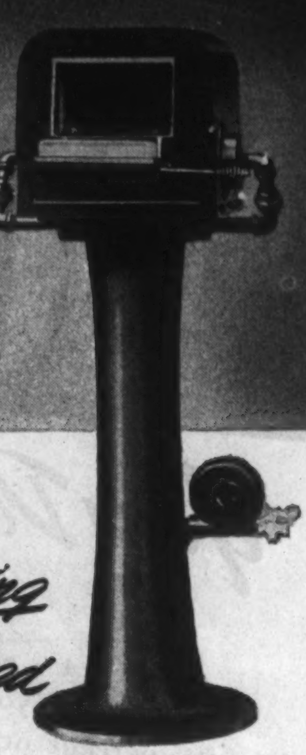
JOHNSON FURNACES

Now

DELIVERED IN ONE WEEK

Today Order the Quick-Heating Economical Furnaces You Need

Here's a break for you! You can now have the Johnson Furnaces you need delivered in only ONE WEEK! No waiting — when you order JOHNSON. Economical to operate, low in original cost, speedy in production, a JOHNSON Furnace is your best buy for NOW and later.



JOHNSON No. 120

Hi-Speed Steel Heat-Treating Furnace, with firebox 5" high, 7¾" wide, 13½" long. Only $129.50 F.O.B. Factory.

Firebox 7" high, 13" wide 16½" long

4-burner $295.00

6-burner $325.00

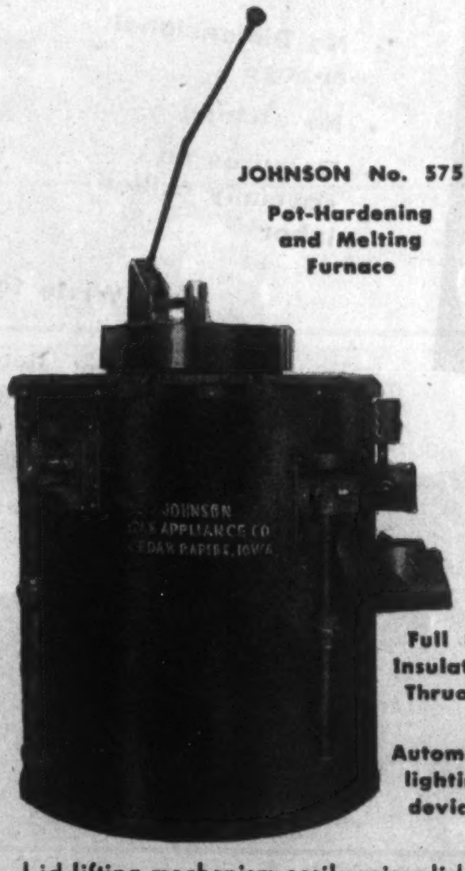
Prices F.O.B. Factory

JOHNSON No. 130-A
Hi-Speed Steel Heat-Treating Furnace

Counter-balanced door opens upward, so tools can be placed or removed without fully opening door — preventing temperature drops.

Carbofrax Hearth ¼ H. P. blower.

Insulating refractory lined 4-burner unit for temperatures 1400 to 2000° F. 6-burner unit for temperatures from 1800 to 2400° F. Complete with motor and blower.



JOHNSON No. 575
Pot-Hardening and Melting Furnace

Full 8" Insulation Thruout

Automatic lighting device.

Lid-lifting mechanism easily raises lid and locks it in UP position. Economical to operate. Large blower assures maximum performance. Steel pot 14" x 20" deep. Complete, $400 F.O.B. factory. Also available with pots 14 x 16 and 14 x 18.

Offices at
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JOHNSON GAS APPLIANCE CO.
E Ave. N.W., Cedar Rapids, Iowa
Please send me free Johnson Catalog.

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Address__________
City__________ State__________

DOWN

Goes Descaling Time...

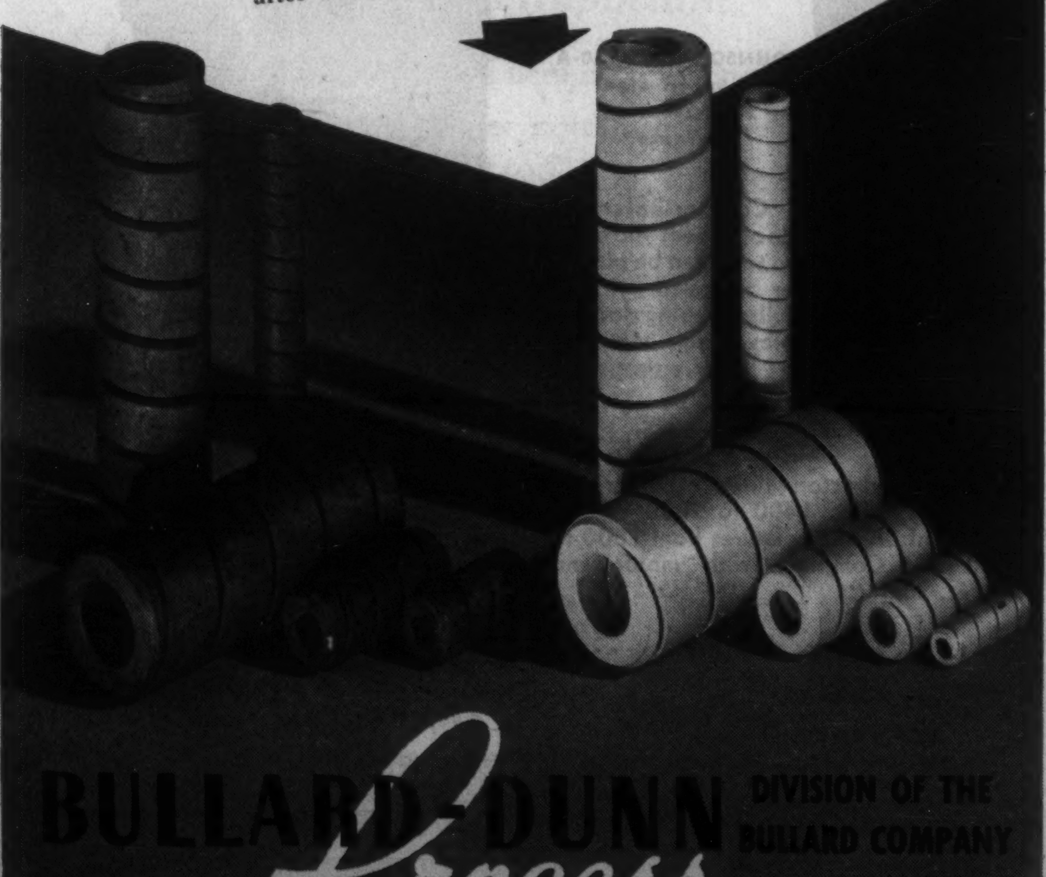
You get a cleaner job with the Bullard-Dunn Process—and you get it faster. Savings in time of fifty percent or more are not uncommon. That's one big reason for its recent adoption by so many plants that value speed as never before.

And think of the other savings too resulting from the following additional advantages:

- No Dimensional change
- No etching
- Requires no specially skilled labor
- Produces chemically clean surfaces
- Can be fully conveyorized
- Long solution life

Write for booklet

Spiral Electric Motor rollers before and after descaling by the Bullard-Dunn Process.



BULLARD-DUNN Process DIVISION OF THE BULLARD COMPANY

BRIDGEPORT, 2 CONNECTICUT

Storage Battery Resistance Welder

What is believed to be the first practical d.c. resistance welder using storage batteries as a source of welding current is announced by *Progressive Welder Co.,* 3050 E. Outer Drive, Detroit 12.

It is now being used for welding aluminum for aircraft assemblies.

It makes possible the application of resistance welding where power supply limitations have prevented use of other forms of stored energy welders. The only requirements are sufficient power to operate a battery charger.

Its use results in lower costs, both initial and operating. Four other advantages are listed: Elimination of inductive losses in the welding "loop" by use of direct current; elimination of reactance losses between power supply and electrodes; less critical adjustments to get consistently good welds; and greater operating and maintenance simplicity.

Two new developments made storage battery operation possible: Creation of a special battery design that will withstand repeated discharge rates and development of a contractor-controller that will control and interrupt enormous amounts of current without arcing.

The battery is the evolution of one designed for certain naval requirements. The contractor-controller is simplicity itself, easily maintained by the average mechanic.

The use of direct current of low voltage provides a more constant effective value of welding current than with other forms of stored energy welders.

Test Magnet for Laboratories

A horseshoe-shaped Alnico magnet measuring 2½ in. high by 3 in. wide with pole bases ¾ x ¾ in., is available through the *Dings Magnetic Separator Co.,* 509 E. Smith St., Milwaukee 7.

It is suitable for test work in chemical, physical, and mineralogical laboratories as well as in smelting and refining plants and others. The unit weighs 14½ oz.

Illuminator for X-Ray Films

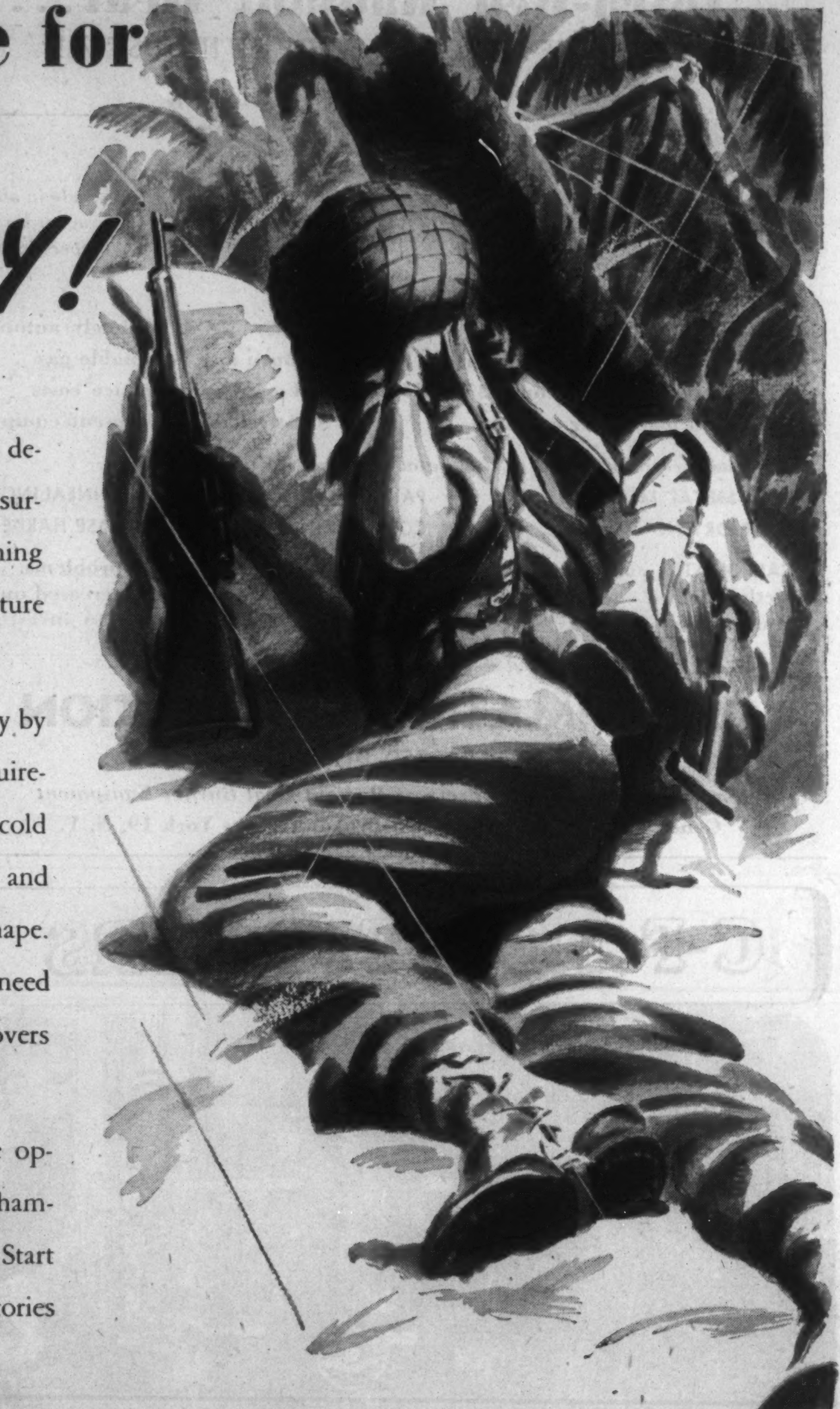
A new high-intensity illuminator for viewing industrial X-ray films, providing four times more illumination than heretofore available, showing detail formerly missed, is being produced by the *Kelley-Koett Mfg. Co.,* Covington, Ky.

It permits finger-tip adjustment to any desired brightness for films of different density, or for different parts of the same film. The intensity results from "Photoflood" lamps that are cooled by a built-in fan that blows air between an inner special heat-resisting glass and an outer flashed opal glass front. Foot-switch control causes the lamps to be "on" only when actually in use.

A feature is an ultra-high intensity "spot," 3 in. in diam., giving four times the brightness of the large section. The glass front of the spot is water-cooled, with the light from the lamp actually passing through 4 in. of water.

This is no time for

EXCESS INVENTORY!



These days of cancellations, cutbacks, and design changes are hardly the time to increase surplus inventories. It's timelier to start streamlining your stocks — to get them "fluid" for future operations.

For example, why not reduce your inventory by buying a larger percentage of your steel requirements from warehouse? Frasse stocks of cold finished bars, tubing, stainless steel, alloy and aircraft steels and tubing are now in good shape. By buying from these stocks only what you need for immediate production, you avoid leftovers and dead material when contracts change.

Cancellations and cutbacks in your future operations may require quick action. Why be hampered with heavy awkward surpluses? Start reducing yours now by using Frasse inventories instead.

Frasse

MECHANICAL AND AIRCRAFT STEELS

SEAMLESS MECHANICAL AND AIRCRAFT TUBING
COLD FINISHED BARS • ALLOY STEELS • AIRCRAFT STEELS • DRILL ROD
STAINLESS STEELS AND TUBING • COLD ROLLED STRIP AND SHEETS • WELDED STEEL TUBING

Peter A. Frasse & Co., Inc. 17 Grand St., N.Y. 13, N.Y. (Walker 5-2200) 3911 Wissahickon Ave., Phila. 29, Pa. (Radcliff 7100—Park 5541)
50 Exchange Street, Buffalo 3, New York (Washington 2000) • Jersey City, N.J. • Hartford, Conn. • Rochester, N.Y. • Syracuse, N.Y.

Infra-Red Radiant Heat . . .
NOW THE ACCEPTED TOOL OF INDUSTRY!

CARBOMATIC

Made in all sizes according to specifications

Examine the advantages offered by
CARBOMATIC INFRA-RED RADIANT HEAT GENERATORS:

- Completely automatic
- Uniform, uninterrupted delivery of heat
- Burn any flammable gas
- Temperature control from 125°—2500°F.
- Lower maintenance costs
- Savings in manpower and fuel
- Attachable to present equipment

Especially recommended to the metal industry for use in:

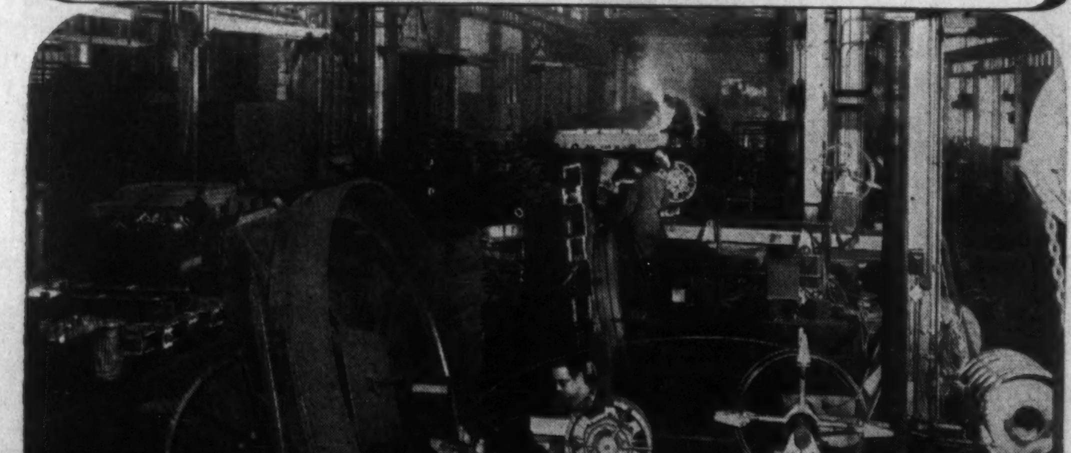
- SOFT METAL MELTING
- STRIP DRYING
- PAINT DRYING
- CORE BAKING
- ANNEALING
- CASE HARDENING

CARBOMATIC engineers are ready to solve your heat-treating problems. Correctly selected equipment assures reduced costs of operation, increased output, and improved quality of your product . . . it will pay you to investigate!

Fully illustrated descriptive circular MA-3 on request.

CARBOMATIC CORPORATION
INFRA-RED DIVISION
Engineers and Manufacturers of Radiant Heat Burner Equipment
General Motors Building, 1775 Broadway, New York 19, N. Y.

C-F POSITIONERS



Automatic Welding —is possible on many jobs if you have a C-F Welding Positioner. Coming in 6 sizes (capacities to 30,000 lbs.) tables tilt to 135° beyond horizontal and rotate 360°, under push button control. Exclusive C-F Variable—Speed control gives table rotations ranging down to 0 r.p.m. for all sizes.
All C-F Positioners are multi-purpose tools equally efficient on either job or production welding.

POSITIONER

Write for Bulletin WP-22

CULLEN-FRIESTEDT CO., 1314 S. Kilbourn Ave., Chicago 23, U.S.A.

Bending and Stretching Machine

A machine for bending and stretching metal parts for aircraft without wrinkles has been developed for *Goodyear Aircraft Corp.*, Akron, Ohio. Called the Roto-Stretcher, it forms parts without wrinkles due to the controlled force it exerts during operations. One man can operate the apparatus. The first machine paid for itself during the first week's operation.

Parts can be formed on this which previously required conventional mechanical dies. The springback, or change in shape after the part leaves the machine, is negligible so that uniformity is assured. It forms parts with contours up to 360°, an operation thought impossible by stretch or bend methods.

Foundry Core and Facing Binder

A new superior dry type foundry core and facing binder of hydrocarbon base has just been announced by the *Bondite Corp.*, 2325 E. 38th St., Los Angeles 11. It will save binder and new sand expense, and will produce cleaner castings and increase production in steel, iron and brass.

It weighs but 4 lb. per gal. On ignition it produces a carbon-type gas that covers surface grains, giving them a protective coating against metal action and prolonging the life of silica sand. Many binders permit sand to fuse.

Bondite works well in old sand. It provides for more permeability, hence finer grained sand may be used.

Plants and Slants

Western Electric Co. has inaugurated a novel method for awarding workmen for time and materials saving ideas. Where the application of a suggestion will result in measurable savings, the award will be 10% of the savings in material and labor estimated to result during the first year's application of the suggestion. Awards will range from $5 to $1,000.

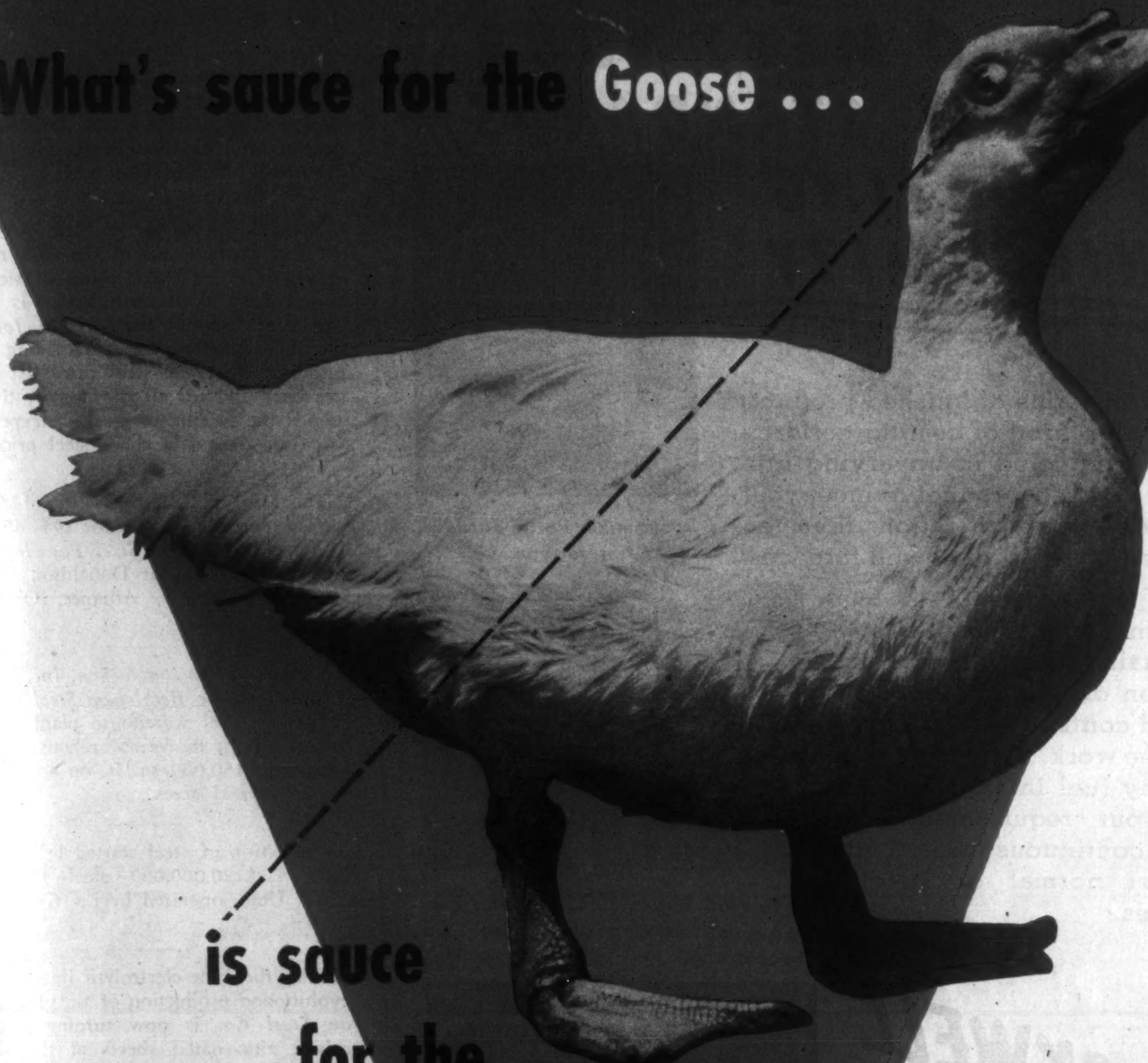
Laclede-Christy Clay Products Co., manufacturers of high temperature products, recently celebrated its hundredth anniversary. During this period the company has developed six lines of products.

Two of *General Electric's* big manufacturing plants have each established safety records of more than 200,000,000 man-hours of work without a fatality, believed to be unequaled in any heavy apparatus manufacturing factory in the country. The plants are at Schenectady and Fort Wayne.

The new process of metal plating on plastics, glass, etc., developed by *Precision Paper Tube Co.*, has been taken over by *Electro Plastic Processes*, 2035 W. Charleston St., Chicago 54.

The Gray-Mills Co., maker of portable coolant systems for the metal working industries, have moved from their Chicago

What's sauce for the Goose . . .



is sauce for the Gander

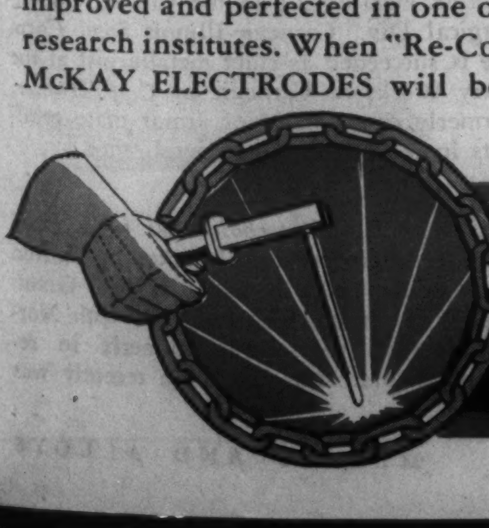
And that applies to welding, too!

For production men agree that Electric Arc Welding—now contributing so essentially to America's wartime production—will play an equally vital part in the manufacturing processes of an approaching peacetime economy. This is just another reason why the **McKay** line of **Stainless, Alloy or Mild Steel Welding Electrodes**—now used nearly 100% for war—is being constantly improved and perfected in one of the nation's leading research institutes. When "Re-Conversion Day" comes, McKAY ELECTRODES will be ready and will embrace the improved metallurgical characteristics required by production-for-peace applications.

Now is the time to ask this 60 year old manufacturer to help you adapt electric arc welding to your present as *well* as to your future needs. McKAY engineers are at your service.

The McKAY line—including **McKay Commercial Chain** for every industrial, maritime or agricultural requirement; and **McKay Tire Chains,** too—will serve you well, both today and in countless applications tomorrow. Let's get better acquainted.

General Sales Office: York, Penna.



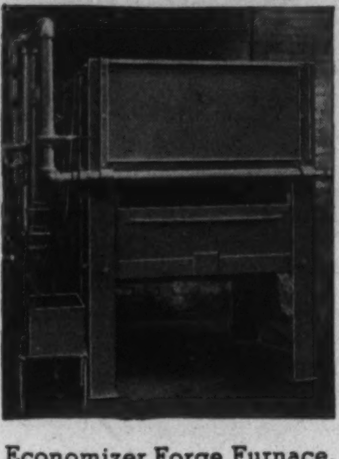
THE McKAY COMPANY
PITTSBURGH, PA.

WELDING ELECTRODES . . . COMMERCIAL CHAINS . . . TIRE CHAINS

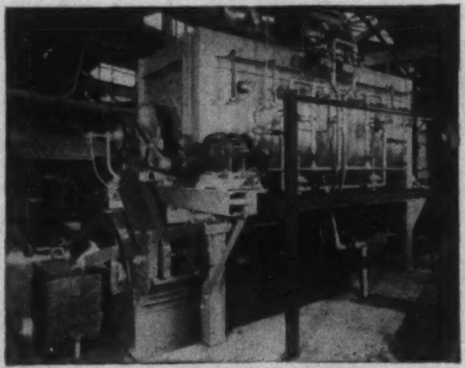
HOW TO MEET YOUR HIGHEST STANDARDS OF HEATING UNIFORMITY

Let's think in terms of finished product: If you want the kind of heating performance that is reflected in unvarying uniformity of finished product to meet your most rigid quality specifications, then you will be wise to install Rockwell furnaces.

Rockwell furnaces, no matter how large or small, embody the correct combination of efficient fuel utilization and controlled heat application to the work. They are available for any fuel in any capacity to meet your requirements for batch or continuous heat treatment under normal or special atmospheres.



Economizer Forge Furnace, recuperative type.



Revolving Retort Heat Treating Furnace, automatic charging and discharging.

Pot Type Furnaces for lead, salt and cyanide hardening, oil tempering, lead and soft metal melting.

ROCKWELL
STANDARD
FURNACES
Oil • Gas • Electric

Write for Bulletins on

- Forging Furnaces
- Revolving Retort Carburizing Furnaces
- Revolving Retort Heat Treating Furnaces
- Portable Oven Furnaces
- Vertical Carburizing and Heat Treating Furnaces
- Pot Type Lead, Salt and Cyanide Furnaces
- Recirculating Air Tempering Furnaces
- Crucible Melting Furnaces
- Tilting Reverberatory Furnaces
- Laboratory Electric Furnaces
- Special Batch or Conveyor Furnaces

CONSULTING SERVICE

In addition to the furnace engineering service, Rockwell offers a complete metallurgical consulting service, involving investigations and recommendations concerning the proper heating and cooling of metal products for uniform results.

W. S. ROCKWELL COMPANY
BATCH TYPE & CONVEYOR FURNACES FOR EVERY HEATING APPLICATION
54 CHURCH STREET NEW YORK 7, N. Y.

quarters to a new plant at 1948-52 Ridge Ave., Evanston, Ill. The new home is two stories, with 50,000 sq. ft. of floor space.

Davison Chemical Corp. has established a new service for the chemical, petroleum, steel and allied industries, known as the Process Division, with executive offices at the home office in Baltimore 3.

A new simplified complete steel price list that contains all of the data required to determine or check prices of steel purchased from warehouse stocks is offered free to all users by the *Earle M. Jorgensen Co.*, Los Angeles, etc. According to the authors, "this new steel price list eliminates once and for all the mystery that surrounds the pricing of steel. Inexperienced help can accurately check steel prices."

The Steel Founders' Society of America has elected for president for 1944-45 Oliver E. Mount, *American Steel Foundries*, Chicago, with F. Kermit Donaldson, *Machine Steel Castings Co.*, Alliance, Ohio, vice president.

Joseph T. Ryerson & Son, Inc. has purchased from the *Bethlehem Steel Co.* their Pittsburgh steel warehouse plant. It consists of a large modern warehouse building, containing 150,000 sq. ft. on an industrial site of several acres.

Production of steel started Feb. 3 at the D.P.C.'s $180,000,000 steel plant near Provo, Utah, operated by the *Geneva Steel Co.*

Using the same electrolytic lines that have revolutioned production of tin plate, *Weirton Steel Co.* is now turning out electrolytic zinc-coated sheets at the rate of 160 ft. per min. in its new precision unit at Weirton, W. Va.

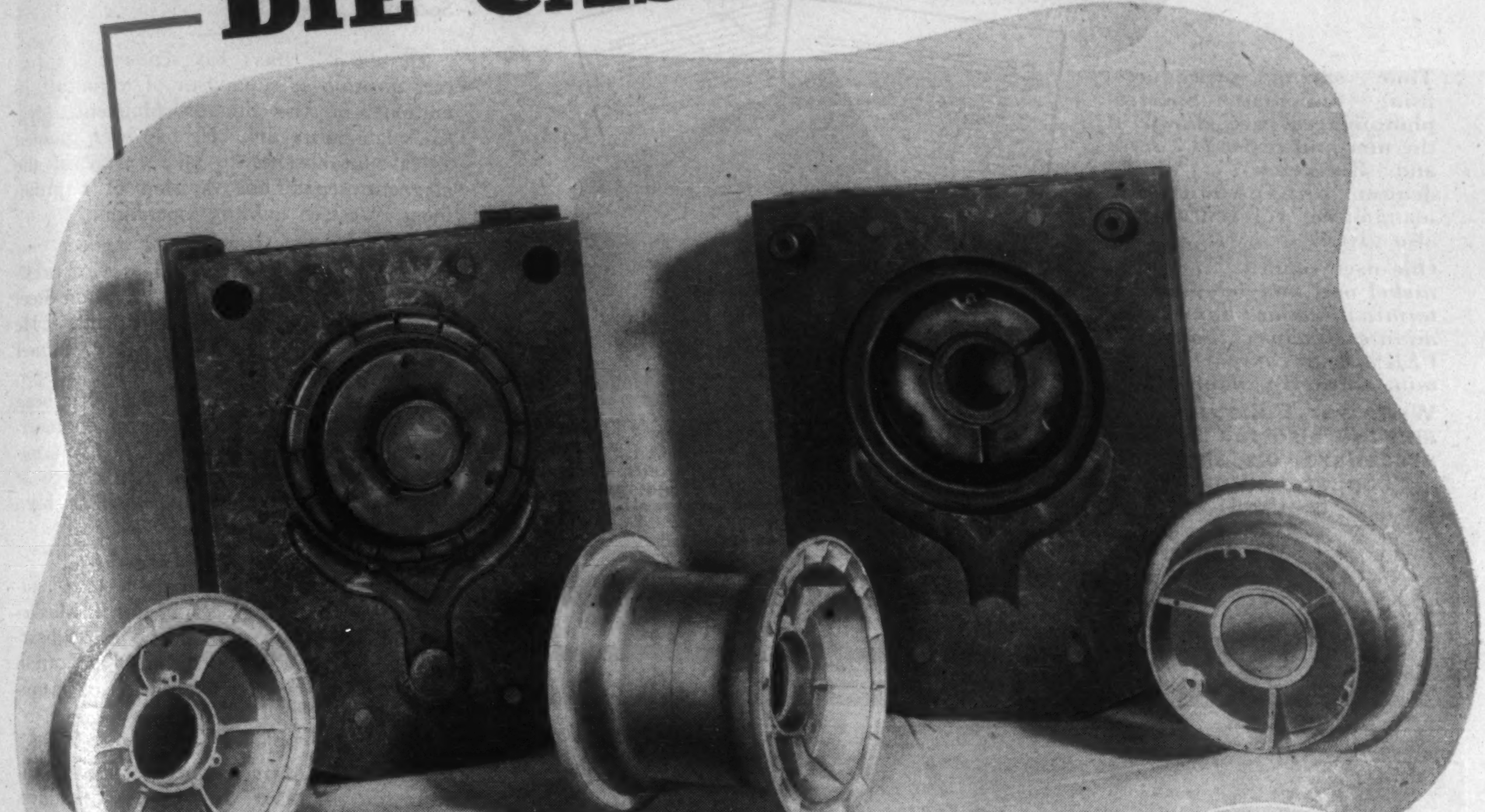
News of Engineers

L. H. Brandt, formerly with the National Ammonia Div. of du Pont, has joined the technical service department of the Pennsylvania Salt Mfg. Co., Philadelphia. He has been prominently identified with ammonia and other heavy chemical utilization in heat treating, oil refining and refrigeration. He is author of many engineering articles on ammonia.

A. N. Swanson has been made chief process metallurgist in the Chicago Metallurgical Div., Carnegie-Illinois Steel Corp. He is succeeded as chief metallurgist at the Gary Works of Carnegie by *C. J. Hunter*, formerly co-ordinator of armor plate products in the Pittsburgh General office.

George E. Westerholm has been made abrasive engineer at Milwaukee by Norton Co., where he will assist F. W. Grant. Mr. Westerholm, who has been with Norton for 21 years, was formerly in research laboratories, and more recently was

LATROBE
DIE CASTING STEELS



For Aluminum—
DYCAST No. 1
DYCAST
LUMDIE

For Zinc—
Z. T. DIE
Z. T. M.

For Brass—
C. L. W.

Latrobe Metallurgists and engineers are abreast of the most recent developments in the increasingly important Die Casting Industry, and their painstaking research is constantly directed toward the production of steels that will improve die performance.

Co-operation between customer and supplier is essential for real success in providing the correct steels to meet the requirements in this field . . . to this can be attributed the results obtained with Latrobe's Die Casting Steels for Aluminum, Magnesium, Zinc and Brass.

We will be glad to give you, without obligation, technical advice on your die-casting steel problems. Write.

LESCO

Latrobe ELECTRIC STEEL COMPANY
MAIN OFFICES *and* PLANT · · LATROBE · PENNSYLVANIA

"..speeded up our work 3 times"

the UNIVERSAL Spectrophotometer

Time saving procedures, using Coleman Spectrophotometers* are shown in the new and revised "Curves and References." Molybdenum, phosphorus and manganese references are also given.

One user reports "*... copper, nickel and molybdenum determinations are done in 20 minutes using the UNIVERSAL, as compared to 90 min. formerly required.*"

Write for Bulletin MA-3 and ask also for detailed procedure on the new copper and nickel method!

* Authorized Coleman Distributors.

Turning one knob permits selection of any color light band required— Coleman Universal Spectrophotometer at $340.00 — replaces visual and filter colorimeters.

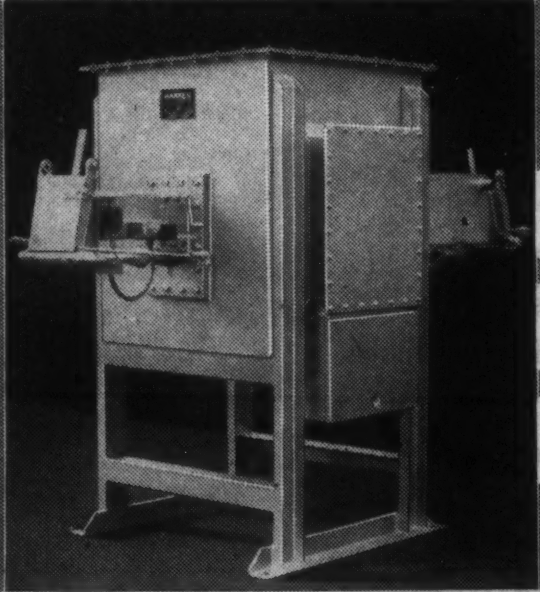
WILKENS-ANDERSON CO.
111 NORTH CANAL STREET • CHICAGO, ILLINOIS

Harper

HIGH TEMPERATURE

Electric Furnaces for

SINTERING POWDERED METALS



Temperature up to 2750°F. Gastight construction for atmosphere control. Photograph shows entrance, high temperature and water cooled chambers with flame curtain at entrance and exit for continuous operation. Various sizes for research and mass production. Used by America's foremost concerns. Write for engineering data.

HARPER ELECTRIC FURNACE CORP.
1461 Buffalo Avenue
NIAGARA FALLS, N. Y.

Representatives in Principal Cities

field engineer serving steel mills and foundries.

Edward C. Hoenicke, assistant to the general manager, Foundry- Div., Eaton Mfg. Co., Detroit, has been made consultant to the newly created Gray Iron Castings Section, War Production Board. Mr. Hoenicke is a director of the Detroit chapter, A.F.A., and chairman of the publicity committee of the Gray Iron Founders' Society.

Harold W. Buus has renewed his former position as supervisor of technical operations in the Stearns Magnetic Mfg. Co.'s laboratory div. He had been granted a leave of absence to take charge of the magnetic separations division of a prominent Western mining operation.

E. J. Anglin has resigned as vice president in charge of operations, Weirton Steel Co., to become general consultant. He is succeeded by *J. S. Williamson,* former general superintendent. *E. W. Rieger,* former assistant to the president, has been made vice president in charge of engineering and development work. *J. J. Munns* has been made vice president in charge of quality control. *C. E. Bayer* has been made general superintendent.

B. M. Staley has been made factory manager of Kaydon Engineering Corp., Muskegon, Mich., maker of ball and roller bearings. He has a broad technical education and extremely varied experience in manufacturing.

Warren H. Mayo has been appointed coordinator of Navy armor plate products of Carnegie-Illinois Steel Corp., with headquarters at Homestead, Pa. He joined Carnegie in 1936 as a practice apprentice and process metallurgist, and has held various positions in the metallurgical department.

R. H. Davies has been appointed welding engineering representative in Washington, D. C. for the Lincoln Electric Co. He was plant engineer in the building of Kaiser's large magnesium plant, the alloy plant, the ferrosilicon plant and the magnesium sand casting foundry at Permanente, Calif. *B. J. Brugge* has been made welding engineer for Lincoln at Detroit. He has served with Persian oil companies in a welding capacity, and redesigned the Army's first all-welded medium tank.

Walter G. Hildorf has been made director of metallurgy of Timken Roller Bearing Co., Canton, Ohio, a newly created office. He was formerly Timken's chief metallurgical engineer. Before joining Timken in 1928, he served with copper and automobile companies. *A. M. Donze,* factory manager, has become vice president in charge of production.

J. L. Wood, mechanical engineer, American Car & Foundry Co., has been made assistant vice president. He has served his company 38 years in an engineering capacity.

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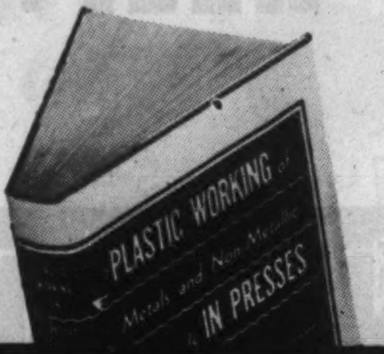

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Arthur Logozzo has been made technical service engineer with MacDermid, Inc., Waterbury, Conn., maker of metal cleaners for plating, etc. He is a leading authority on hard chromium plating, and has addressed technical societies on this subject.

L. P. McAllister, metallurgical engineer for Lukens Steel Co., has been made assistant to the superintendent, specializing on quality control. *Joseph G. Althouse* has been made metallurgical engineer, and *William Taylor* engineer of tests.

Briefs on Associations, Promotions and Education

Articles of incorporation for the Cutting Tool Manufacturers' Assn., a non-profit organization, have been filed in Wilmington, Del., following an organization meeting at Detroit. Membership is limited to individuals and firms making tools for use with power-driven machinery, hand-operated tools being excluded. Among the directors is Oscar L. Bard, president, Michigan Tool Co., Detroit.

Charles Ellison MacQuigg, dean of engineering at Ohio State University, was given the James Turner Morehead medal of the International Acetylene Assn. for "advancing the oxy-acetylene processes through metallurgical research and for leadership in welding engineering education."

The American Foundrymen's Assn. developed a new code, No. 7, for fostering foundry safety and hygiene, giving necessary engineering data and minimum requirements for industrial housekeeping and sanitation. Large scale employment of women led to the formulation of the code.

A chemical and metallurgical institute for the exchange of information among university and commercial scientists has been established at the former home of Frank W. Woolworth at Glen Cove, L. I. The plan is sponsored by Richard S. Reynolds, Jr., president of the Reynolds Metals Co. and the Reynolds Research Institute.

The Society of Automotive Engineers is the first professional society to win an honor in the field of engineering, which is similar to the Army-Navy "E" in the field of production. It is called the U. S. Army Ordnance Distinguished Service Award "in recognition of outstanding and meritorious engineering advisory services in war and peace; in design, manufacture and maintenance of ordnance material."

Plans are being made by the American Society of Tool Engineers for the holding of the largest exhibition in history of production equipment, tools, and machines approximately 90 days after the end of the war in Europe.

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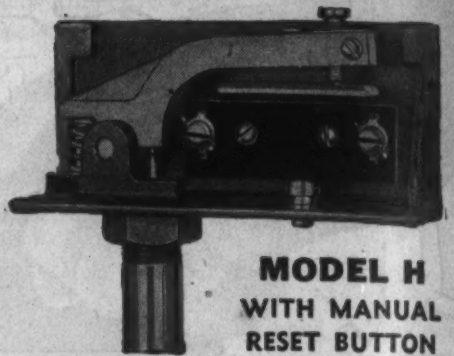

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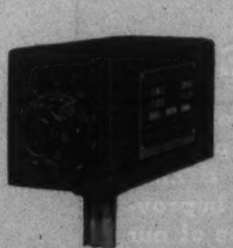

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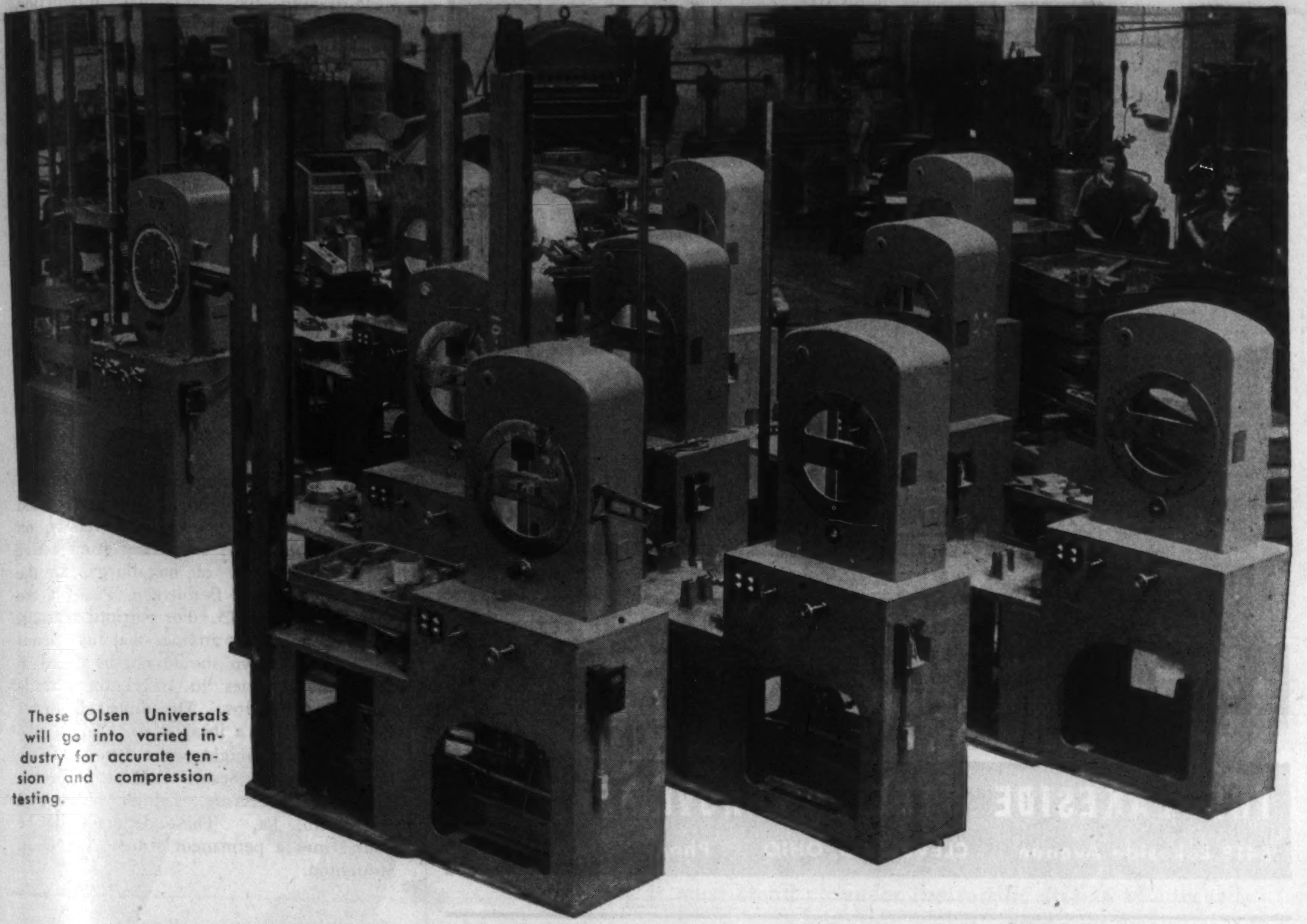

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Portraying the spectacular production story of nickel from crude matte to mirror-finish sheets, a new 16-mm. sound film, 32 minutes, entitled "Nickel and Nickel Alloys," has been issued by the Bureau of Mines for free distribution. Applications should be made to: Graphic Services Section, Bureau of Mines, 4800 Forbes St., Pittsburgh 13.

An unusually practical demonstration of foundry methods, from actual blueprints and patterns to the finished casting, was devised recently by the Eastern Div., Steel Founders Society of America, and set up, together with a melting furnace in full operation, in the Hall of Prime Movers at the Franklin Institute, Philadelphia. Demonstrations open to the public will continue regularly for the duration.

A subscription stag dinner in honor of Dean Bradley Stoughton is being planned by his associates at Lehigh University, on the occasion of his retirement from active duty as professor of metallurgy, at the Hotel Bethlehem, Bethlehem, Pa., on the evening of April 15. For patriotic reasons, Dean Stoughton is anxious that his friends from out of town should not be asked to leave their duties to travel on already overcrowded trains. The dinner is therefore planned as a local affair. Those who do not attend might write letters of appreciation to the Secretary, Dept. of Metallurgical Engineering, Lehigh University, Bethlehem, Pa. These letters will be bound into a permanent volume for Dean Stoughton.

House Organ Notes

U. S. Steel News, U. S. Steel Corp. of Del., Jan. 1944.

A leading feature article describes the Monongahela Valley project, the largest war-time addition to the steel producing capacity of the country, now nearing completion. It is complete as to hot metal producing facilities, turning out over 1,000,000 tons of steel ingots annually.

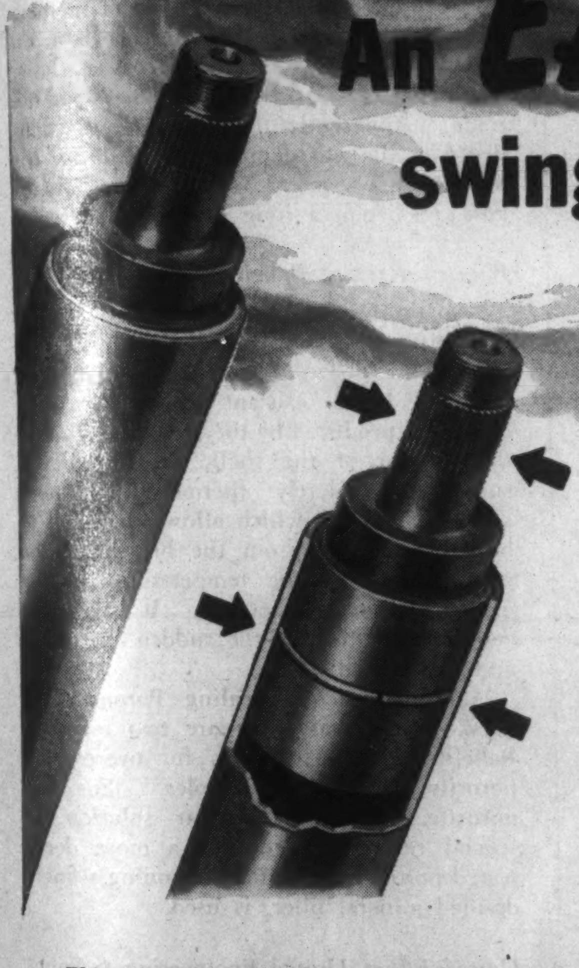
We quote from another article, "Metal of Destiny": "Steel may be machinable or weldable. . . . It may be hard enough to scratch glass, or soft enough to be scratched by a needle. . . . It may be ductile enough to be drawn to a diameter one-third the thickness of human hair. . . . It may be hard on the surface and ductile within. . . . It may be strong enough to withstand a pull of 500,000 p.s.i. . . . It may be resistant to heat or cold, to rust or chemical attack. . . . It may be capable of withstanding the shock of sudden blows, or the strain of vibration or twisting."

Looks like steel isn't licked yet!

Aluminum News-Letter, Aluminum Co. of America, Jan. 1944.

It starts off: "Pardon us while we take a bow. With this issue A.N.-L. celebrates its tenth birthday. In the Feb. 1934 issue we find the announcement of the first all-aluminum train, the Union Pacific's three-car, high-speed streamliner, which 'weighs only as much complete as a single Pullman sleeping car.' "

An EASY-FLO brazed joint swings PT boats into action



This cutaway view shows how the brazing alloy is applied. The brass steering wheel fitting, with a ring of Easy-Flo wire preplaced in a groove, is thoroughly cleaned, fluxed and positioned in the end of the brass tubular steering column and heat is applied uniformly with 4 natural gas burners at points indicated by the arrows. When Easy-Flo melts, it penetrates the entire joint area and appears around both ends of the fitting.

At the left you see how an Easy-Flo brazed fitting which mounts the steering wheel of a PT boat is brazed to the steering column. A great deal of responsibility rests on this joint when a PT goes into action. It must stand up under the terrific strains of unusually sharp turns, one way and the other, as the PT boat maneuvers at high speed. Battle records prove that it does this unfailingly.

This job, like hundreds of others in war production, was switched to Easy-Flo because this low temperature silver brazing alloy consistently makes strong joints and does it in fast time. By using the joint design shown, brazing time was cut to 2 minutes. Costs naturally, were reduced, too.

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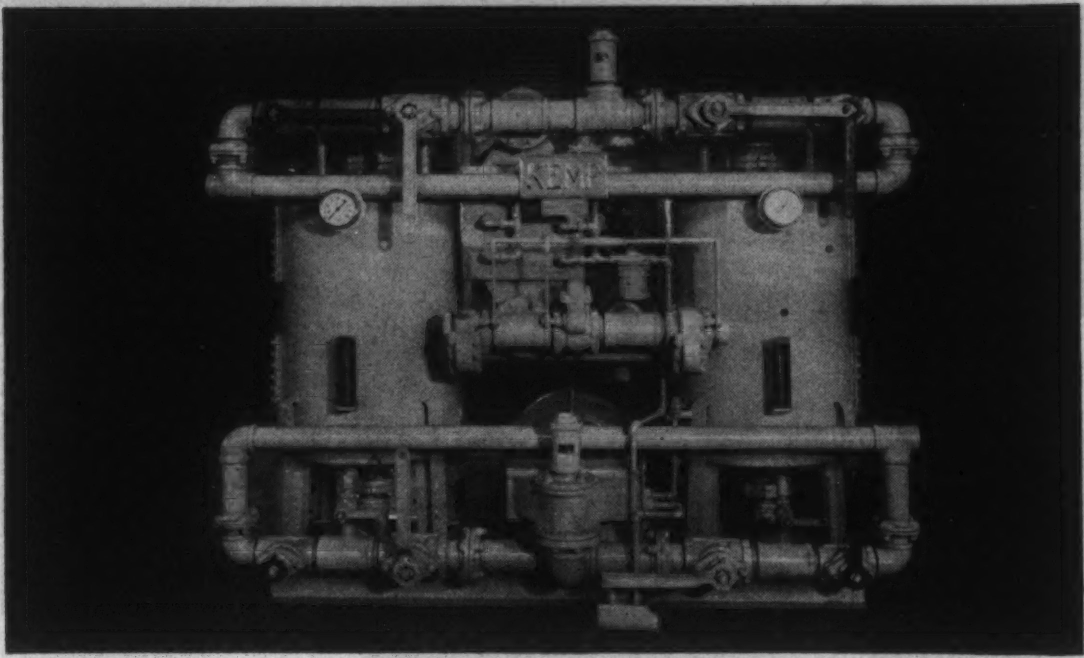

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And here is a sketch on aluminum foil: "No matter how thin you roll it, it's still aluminum. If rolled to a thickness of 0.005 in. or less, it is foil. Rolling takes place in three steps, the starting material being coiled sheet 0.026 in. thick. It is annealed and sheared to width, then passed through several breakdown mills, being reduced 40 to 60% per pass. Now 0.009 to 0.002 in. thick, it goes to the intermediate mills, thence to the highly polished finishing rolls."

And, speaking of their 10-year history, "In our early years we survived 'The Music Goes Down and Around' and now we're struggling through 'Pistol Packin' Mamma.' "

The Eutectic Welder, Eutectic Welding Alloys Co., Feb. 1944.

The leading article gives a digest of an article in METALS AND ALLOYS, Sept., 1943, on "Eutectic Low Temperature Welding," by Robert S. Burpo, Jr. This new publication proposes to present data on design, metallurgy, method, cost analysis, useful tools, helpful hints and news of the trade. Apparently the editors have confidence to the nth degree in publishing, for their editorial states: *"The Eutectic Welder* has just begun a long and useful career."

Bakelite Review, Bakelite Corp., Jan. 1944.

"Coatings for Steel Cartridge Cases" is a feature article explaining the application of Bakelite phenol resin-baking finishes on cases. "It is resistant to the corrosive chemicals produced by the powder charge in the interior of the shell. It provides a smooth, completely thermosetting, non-softening coating which allows the shell to be ejected easily from the breach of the gun even when the temperature in that gun breach reaches 600 F. It is flexible enough to withstand the sudden expansion and contraction."

Another article, "Sealing Porous Castings," states that there are two types of Bakelite sealing solutions for overcoming porosity or small blowholes. For fine porosity, BV-1845, a clear solution of special resin, is used; for a more deep-seated porosity, BE-2106, containing a finely divided mineral filler, is used.

United Effort, United Engineering & Foundry Co., Jan. 1944.

In "The Story Behind "Battleship X,'" leading feature article, we learn that the N. Y. Shipbuilding Corp. lost many workers because after the launching the young fellows who helped build the ship volunteered in the Navy to help man the "South Dakota." In fact, the yard lost 25% more workers this way than through Selective Service.

"Draft boards are not shipbuilders. They wouldn't know the difference between a tack welder and a hull welder. You can train the former in a couple of months, but the hull welder is a rare jewel of an artist." However, this Camden, N. J., yard had worked out cooperation with the local draft board, avoiding many pitfalls.

The Parkerizer, Parker Rust-Proof Co., Jan. 1944.

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Mechanical Topics, International Nickel Co., Inc., Vol. 7, No. 1.

"When the Navy boosted war-time operating temperatures of marine turbines, one obstacle to efficient performance was curtailing turbine heat losses. Operating up to 850 F., turbines could not wear ordinary insulation. Asbestos, being hygroscopic, would absorb corrosive moisture from sea air. Wires used in the asbestos blanket had to be corrosion-resistant, heat-resistant and strong enough to stand vibration. At length, Monel wires were used as a base for the weave."

Meetings and Expositions

AMERICAN SOCIETY OF TOOL ENGINEERS, annual meeting. Philadelphia, Pa. March 26-28, 1944.

AMERICAN GAS ASSOCIATION, Industrial and Commercial Gas War Conference. Rochester, N. Y. March 30-31, 1944.

AMERICAN CERAMIC SOCIETY, annual meeting. Pittsburgh, Pa. April 2-5, 1944.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Birmingham, Ala. April 3-5, 1944.

AMERICAN CHEMICAL SOCIETY, National meeting. Cleveland, Ohio. April 3-7, 1944.

SOCIETY OF AUTOMOTIVE ENGINEERS, National Aeronautic meeting. New York, N. Y. April 5-7, 1944.

ELECTROCHEMICAL SOCIETY, spring convention. Milwaukee, Wis. April 12-15, 1944.

AMERICAN ZINC INSTITUTE, annual meeting. St. Louis, Mo. April 17-18, 1944.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Open Hearth and Blast Furnace Conference. Pittsburgh, Pa. April 20-21, 1944.

AMERICAN FOUNDRYMEN'S ASSOCIATION, annual meeting and 3rd War Production Foundry Congress. Buffalo, N. Y. April 25-28, 1944.

INSTITUTE OF THE AERONAUTICAL SCIENCES, spring meeting. Detroit, Mich. April 27, 1944.

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By Edwin F. Cone

Post-War Aluminum

A 1,000,000-ton aluminum factory will look small to this country within the next 10 yr., said Walter L. Rice, president of the Reynolds Mining Corp., in a public address. If this country were to manufacture only 5,000,000 automobiles per year, as it did before the war, and use as little as 400 lb. of aluminum per car, this would require 1,000,000 tons of the metal or virtually the entire output of the Government-owned plants as well as the privately owned ones. Prior to the war only 29% of the aluminum produced had gone into transportation, but he predicted that this figure would be increased to between 60 and 70% after the war when trucks, automobiles and railroad cars would be made, at least in part, of aluminum.

War Consumption of Leading Metals

From a study of the comparative annual rates of consumption of some 30 leading metals and minerals for this war as compared to World War I, magnesium stands at the top of the list the use of which is about 1,400 times as great while the next greatest increase is in aluminum with a consumption rate 20 times as great. Next to these comes copper nearly 5 times, petroleum nearly 4 times, and steel nearly twice as great.—From an address by A. H. Bunker, vice chairman for metals and minerals of the WPB.

More Pig Iron—Less Furnaces

The average daily production of all American blast furnaces today is nearly double the average output of 1918. The nearly 250 furnaces in 1943 are far exceeding the combined output of the 410 stacks that were in blast during 1918, the peak year of World War I. Several furnaces can operate at a daily production rate of 1,600 tons as compared with 630 tons, the approximate top daily output of the largest units in 1918.

"Intensifiers" in Steel

The use of intensifiers has helped to stretch the supplies of alloying elements, but "needling" could have been utilized much more extensively had not the supply of alloys recoverable from scrap turned out to be fairly adequate, says W. O. Philbrook, research metallurgist, Wisconsin Steel Works, International Harvester Co., in an article in *Mining and Metallurgy* for February. Needled steels should enter the picture prominently after the war when consumers sit down to decide on a purely competitive basis what steels will be used for their gears, shafts and other heat-treated parts. In the postwar competitive period, the price element may enter into the question of the use of a cheap hardener like boron as against a more expensive higher-priced alloy steel.

Expansion in Steel Castings

An estimated tonnage of 1,679,178 net tons in 1942, based on surveys by the Steel Founders' Society of America, is published by that organization. The fairly rapid war expansion in this field is reflected by the 1,389,768 tons made in 1941, the 855,252 tons in 1940 and the 633,305 tons for 1939. Taking the 361,632 tons and the 23,972 employees in 1938 as 100, the production index for 1942 is 464.3 and the number of employees index 355.

Tantalum in Surgery

Tantalum, a relatively rare metal characterized by extreme resistance to corrosion, is proving invaluable to surgeons in repairing bones, especially the skull, and in joining together nerves that have been severed.—*The Chemical Digest*

Demand for Locomotives

It is expected that there will be a considerable demand for locomotives, both diesel and steam, immediately following the war. It is estimated that about 70% of all locomotives are 20 yr. old.

Better Safety Records

There has been an improvement in the safety records of several large plants. For example, two of General Electric's large manufacturing plants have each established safety records of more than 200,000,000 man-hours of work without a fatality, believed to be unequalled in any heavy apparatus manufacturing factory in the country, according to a statement for the company. Since the last fatality in the Schenectady Works, more than 2 yr. ago, the plant has worked 211,124,832 man-hours. Close to this record is the Fort Wayne, Ind., Works with 200,272,098 man-hours since its last fatality.

Heat-Treating Furnaces

Monthly shipments of heat-treating furnaces are currently (January), says the WPB, approximately 50% of the peak level which has been maintained during the last quarter of 1942 and the first half of 1943. New orders, which had dropped off sharply after the peak of mid-1942 of $22,000,000, have since fluctuated between $4- and $5,000,000 per mo. It is anticipated that the monthly rate of shipments will not continue the present downward trend but will stabilize in the neighborhood of between $5- and $6,000,000.

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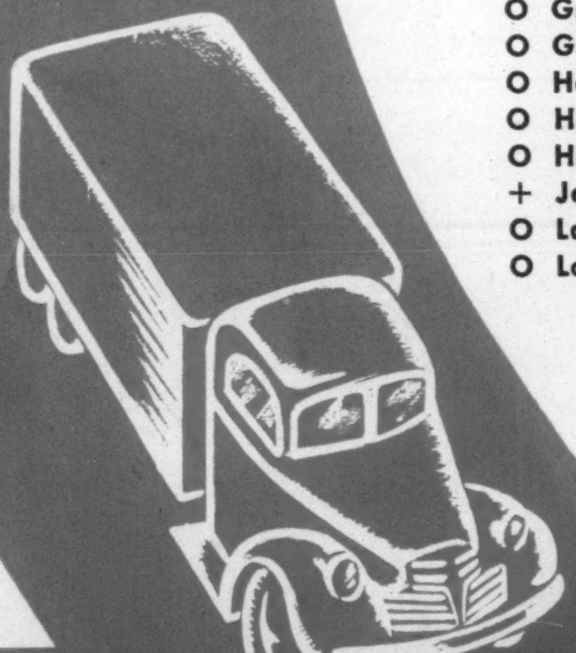

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